HEADQUARTERS

OGDEN AIR LOGISTICS CENTER

UNITED STARES AIR FORCE

HILL AIR FORCE BASE, UTAH 84406

(6)

SURVEILLANCE REPORT
STAGE I
DISSECTED MOTORS
PHASE IX

PROPELLANT AND COMPONENT TESTING

(9) Quarterly rept.

PROPELLANT LAB SECTION

(10) John A. Thompson

(14) MANCP-REPORT NR. 392(78) moved

(11) MAR 78

(12) 96p.

MANCP REPORT NR 392(78)
MMEMP PROJECT M82934C-WNL17514

SURVEILLANCE QUARTERLY REPORT

STAGE I DISSECTED MOTORS

PHASE IX PROPELLANT & COMPONENT TESTING

Author

JOHN A. THOMPSON, Chemist
Component & Combustion Test Unit

Engineering & Statistical Review By

JOHN K. SCAMBIA, Project Engineer
Service Engineering

EDWARD J. ERICKSON, Statistician
Data Analysis Unit

Recommended Approval By

RONALD F. LARSEN, Chief
Physical & Mechanical Test Unit

LEONIDAS A. BROWN, Chief
Component & Combustion Test Unit

Approved By

DON F. WOODS, Chief
Propellant Laboratory Section

March 1978

HO26337

Industrial Products & Ldg Gear Division
Directorate of Maintenance
Ogden Air Logistics Center
United States Air Force
Hill Air Force Base, Utah 84406

ABSTRACT

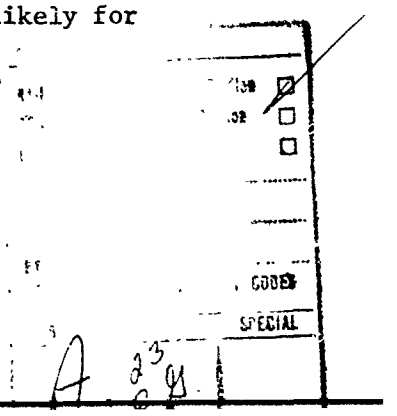
Testing was performed to determine the useful shelf/service life for LGM-30 Stage I Rocket Motors. A three year storage program for propellant and components was started in May 1961. This program was then extended to a ten year study and later continued indefinitely to assure that a deterioration in motor physical characteristics could be detected in time to take some corrective actions before the weapon system performance deteriorated below an acceptable level.

This report covers only propellant data and limited case bond data. The malfunction of an environmental chamber destroyed component samples that had originally been part of this testing program (and the inadvertent burning of some motors during dissection reduced the material available for testing). Planned dissection of selected motors in the future will provide samples for continued component testing. Test specimens for this reporting period were obtained from motors STM-012, 0012099, 0012199 and UP7775 block propellant.

Separate analyses were made on the respective motors and block propellant for the first time in this report and are shown in the regressions. The plotting symbols for each motor and block propellant are listed in the statistical analyses section.

The data from this test period was combined with data from previous testing and entered into the G085 computer for storage, analysis, and regression analysis. From the statistical analysis of all data tested to date, significant degradation of the propellant does not appear likely for at least two years past the oldest data point.

Future testing will be conducted on dissected motors.



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GLOSSARY OF TERMS AND ABBREVIATIONS

Aging Trend	A change in properties or performance resulting from aging of material or component
CSA	Cross Sectional Area
DB	Dogbone
Degradation	Gradual deterioration of properties or performance
E	Modulus (psi), defined as stress divided by strain along the initial linear portion of the curve.
EB	End Bonded
EGL	Effective Gage Length
em	Strain at maximum stress
er	Strain at rupture
"F" ratio	The ratio of the variance accounted for by the regression function to the random unexplained variance. The regression function having the most significant "F" ratio is used for plotting data. The ratio is also used in detecting significant changes in random variation between succeeding time points
JANNAF	Joint Army, Navy, NASA, Air Force Committee
MANCP	Propellant Lab Section at Ogden Air Logistics Center
Ogden ALC	Ogden Air Logistics Center, Air Force Logistics Command
r or R	The Correlation Coefficient is a measure of the degree of closeness of the linear relationship between two variables
Regression Equation	The general form of the regression equation is $Y = a + bx$
Regression Line	Line representing mean test values with respect to time
S_b	Standard error of estimate of the regression coefficient

GLOSSARY OF TERMS AND ABBREVIATIONS (cont)

S_e or $S_{Y.X}$	Standard deviation of the data about the regression line
Sm	Maximum Stress
Sr	Stress at rupture
Standard Deviation (S_y)	Square root of variance
Strain Rate	Crosshead speed divided by the EGL
"t" test	A statistical test used to detect significant differences between a measured parameter and an expected value of the parameter (determines if regression slope differs from zero at the 95% confidence level)
Variance	The sum of squares of deviations of the test results from the mean of the series after division by one less than the total number of test results
3 Sigma Band	The area between the upper and lower 3 sigma limit. It can be expected that 99.73% of the inventory represented by the test samples would fall within this range assuming that the population is normally distributed.
90-90 Band	It can be stated with 90% confidence that 90% of the inventory represented by the test samples would fall within this range assuming that the population is normally distributed

INTRODUCTION

A. PURPOSE:

This report contains test data from samples of LGM-30 Stage I, Wings I-V TP-H1011 propellant and case bond specimens. Testing was performed by the Propellant Laboratory Section (MANCP) for the Engineering and Reliability Branch of the Airmunitions Management Division (MMWRM) under Project M82934C-WNL17514. This report is the ninth in this series. Data from this test period and propellant test data from the eight previous reports were entered into the G085 computer for regression analysis. The regressions are shown in this report.

B. TEST PROGRAM:

The LGM-30 Laboratory and Component Program includes the testing of materials used in the main case, aft closure, ignition assemblies, and main grain propellant. This report covers TP-H1011 propellant and case bond specimens. Table I outlines the test program.

Propellant for testing was obtained from three dissected motors, STM-012, a motor prepared by Thiokol specifically for dissection, S/N 0012099, A SLIM motor, and motor S/N 0012199 selected from the inventory for dissection and UP-7775 block propellant.

C. HISTORICAL BACKGROUND:

In May 1961, Thiokol began a three year LGM-30 laboratory storage and test program to determine the rate of degradation with age for Stage I materials. During June 1962 and again in August 1963, additional samples were included. New samples were added in July and August 1964 when the

surveillance testing program was extended to ten years (Test Plan 0717-62-0967, 53-8). Carton block propellant, batch UP-7775, containing TP-H1011 propellant cast in March 1962 was added to the program in 1964.

Samples added to the inventory in 1964 were considered to be a new population, but were combined in regression analysis with the three dissected motors. The history of testing of these materials is found in MQQP Report Nrs. 109A(67), 144(68), 208(71) and 358(76). Physical transfer of the specimens from Thiokol to Ogden ALC was made in June 1967.

TABLE I

TEST PROGRAM

All Temperatures in Fahrenheit

STM-012, SN 0012099, SN 0012199, UP-7775

Test	Conditions	Spec/ Cond	Spec Conf
Tensile	77°, 2.0 & 20 in/min	5 ea	JANNAF Dogbone
Creep	77°, 10 & 12 lb load	3 ea	JANNAF Dogbone
Stress Relax	77°, 3 & 5% strain	3 ea	1/2" x 1/2" x 4"
Strain Dilatation	77°, .25 in/ in/min	3 ea	1/2" x 1/2" x 4"
Hardness	77°, initial 7 10 sec	5 ea	Dogbone Ends
HOE	77°	3 ea	1/2" x 3/8" x 1"
Burning Rate	77", 500 & 1,000 psi	5 ea	.156" x .156" x 5"
DTA	77° start	3 ea	0.040" wafer
Ignitability	77°, 168 cal/ cm^2/sec	3 ea	0.050" wafer
Sol Gel	77°	6 ea	1/2" x 1/2" x 1/2"
UP-7775 will NOT be used on the following tests:			
High rate Tensile	77°, 1,000 in/in/min	5 ea	3/4" GL Dogbone
Triaxial High Rate	77°, 1,000 in/in/min 600 psi	3 ea	3/4" GL Rail
Dynamic Response	77°, 70 gm ct wt	3 ea	3.3" x .33" x 0.690" disc
Biaxial constant Strain	77°	3 ea	3/4" GL Rail

TABLE I (cont)

Test	Conditions	Spec/Cond	Spec Conf
Failure Envelope	Temp: -50° -20°, 10° 40°, 77° 130°, & 180°F at a rate of 0.2, 2.0, & 20 in/min	3 ea	JANNAF Dogbone
STM012 and 0012199 only will be for the following tests:			
Case Bond Tensile	77°, 0.2 in/ min	10 ea	1" x 5/8" x 3/4"
Tear Energy	77°F ± 2°	8ea	0.1" x 1.18" x 3"
Poisson's Ratio (Strain Dilatation) 10, 15, 20 25, 30%	77°F ± 2°	6 per/ condition	0.50" x 0.50" x 4"

STATISTICAL ANALYSIS

The objective of this statistical analysis is to determine whether or not any aging trends are demonstrated by accumulated test data in order to assist Service Engineering to more accurately predict motor serviceability.

Propellant was made available for testing and statistical analysis to obtain an overall view of the aging trends affecting the First Stage Dissected Motor Program. The sampling consists of data from two dissected operational motors (0012099 and 0012199), and carton propellant (batch UP-7775). One motor (STM-012) was prepared by Thiokol specifically for the dissection program.

A Multi-symbol Regression Analysis Program was used to determine aging trends. The sampling is combined for each test parameter in a single regression analysis. The linear equation ($Y = a + bX$) was found to be the best fit model for the data in this report. A composite population aging trend line is then calculated accepting the fact that individual aging of different populations may be masked.

The Multi-symbol Program uses a unique plotting code for each motor and carton data on the regression plots. This method of data plotting allows a visual display of the overall relationship between the various origins of data and how they relate to the overall least square aging trend line.

The regression program uses an analysis with individual data points from different time periods combined to establish a least squares aging trend line for the overall data. The variance about the regression line, obtained using individual values of the dependent variable, was used to compute a tolerance interval such that at the 90% confidence level 90% of the population falls within this interval. This tolerance interval was

extrapolated to a maximum of 24 months to give an indication of the statistical significance of the slope of any aging trends. The computer tolerance interval about the composite regression line is wider than what the tolerance interval would be about any individual motor or carton regression line because of the increased data spread introduced by combining different populations of data. The "t" values and the significance of this statistic, which are reported for each regression model, gives an indication of the "statistical significance" of the slope of the aging trend in the Y-axis. Data and regression trend lines were plotted utilizing an IBM-360/65 computer.

ORIGIN SYMBOL TABLE

Origin	DOM	Wing	Symbol
Motor 0012099	63166	2	0
Motor 0012199	63227	2	1
Motor STM-012	61221	1	S
Carton UP-7775	62075	1	U

TEST RESULTS

Regression analysis is the method of evaluation used in the analysis of the test results.

A. TENSILE:

Low rate (2.0 in/min) tensile testing data shows a statistically significant gradual decrease for strain at maximum stress and strain at rupture. Modulus shows a statistically significant gradual increase. Maximum stress and stress at rupture shows no significant change (Figures 1 thru 5).

The 20 in/min low rate tensile testing shows a statistically significant gradual decrease for strain at maximum stress and stress at rupture with the other regressions showing no significant change (Figures 6 thru 10).

The high rate strain parameters show a statistically significant gradual decrease (Figures 11 and 13). The stresses and modulus do not show a statistically significant change (Figures 12, 14 and 15).

High rate triaxial testing shows a statistically significant increase for strains and stresses (Figures 16 thru 19). The modulus shows a statistically significant decrease (Figure 20).

Case bond tensile shows a statistically significant decrease (Figure 21).

B. CREEP:

For both the 10 and 12 pound load no significant change is shown except for the 10 pound load at 20 sec which shows a statistically significant gradual decrease (Figures 22 thru 29).

C. STRESS RELAXATION:

Stress relaxation modulus for both 3 and 5% strain shows no significant change (Figures 30 thru 37).

D. CONSTANT STRAIN:

A statistically significant decrease is shown for constant strain (Figure 38).

E. SHORE HARDNESS:

The Shore A ten second hardness shows no significant change (Figure 39).

F. BURNING RATE:

A statistically significant decrease is shown for both the 500 and 1,000 psi initial testing (Figures 40 and 41).

G. HEAT OF EXPLOSION:

The heat of explosion does not show a significant change (Figure 42).

H. IGNITABILITY:

No significant change is seen in the data by the regression (Figure 43).

I. DIFFERENTIAL THERMAL ANALYSIS (DTA):

The endotherm and first exotherm do not show a significant change (Figures 43 and 45). The ignition temperature shows a statistically significant increase (Figure 46).

J. SOL GEL:

A statistically significant gradual decrease is shown for percent extractables, gel swell ratio, sol gel density and cross link density (Figures 47 thru 50).

K. FAILURE ENVELOPE:

Failure envelopes for STM-012 and 0012199 test data are shown in Figures 51 and 52 respectively.

CONCLUSIONS

The test results show that, under present storage conditions, some of the physical/mechanical and combustion properties of the propellant indicate statistically significant aging trends. On some regressions where a significant trend is indicated, the slope of the trend line is quite gradual and no operational problems are expected. On other regressions, i.e., triaxial tensile and burning rate, the slope of the trend line appears quite steep although, in reality, the percent change is minor as indicated by the formulas found at the top of each figure. The Y-axis range is automatically varied by the data spread to provide visibility between individual data means. As a result, the range values (on Y-axis) must be considered when visually analyzing regression slopes.

Although some aging trends have been observed, it does not appear that any significant degredation will occur in the propellant within the next two years.

RECOMMENDATIONS

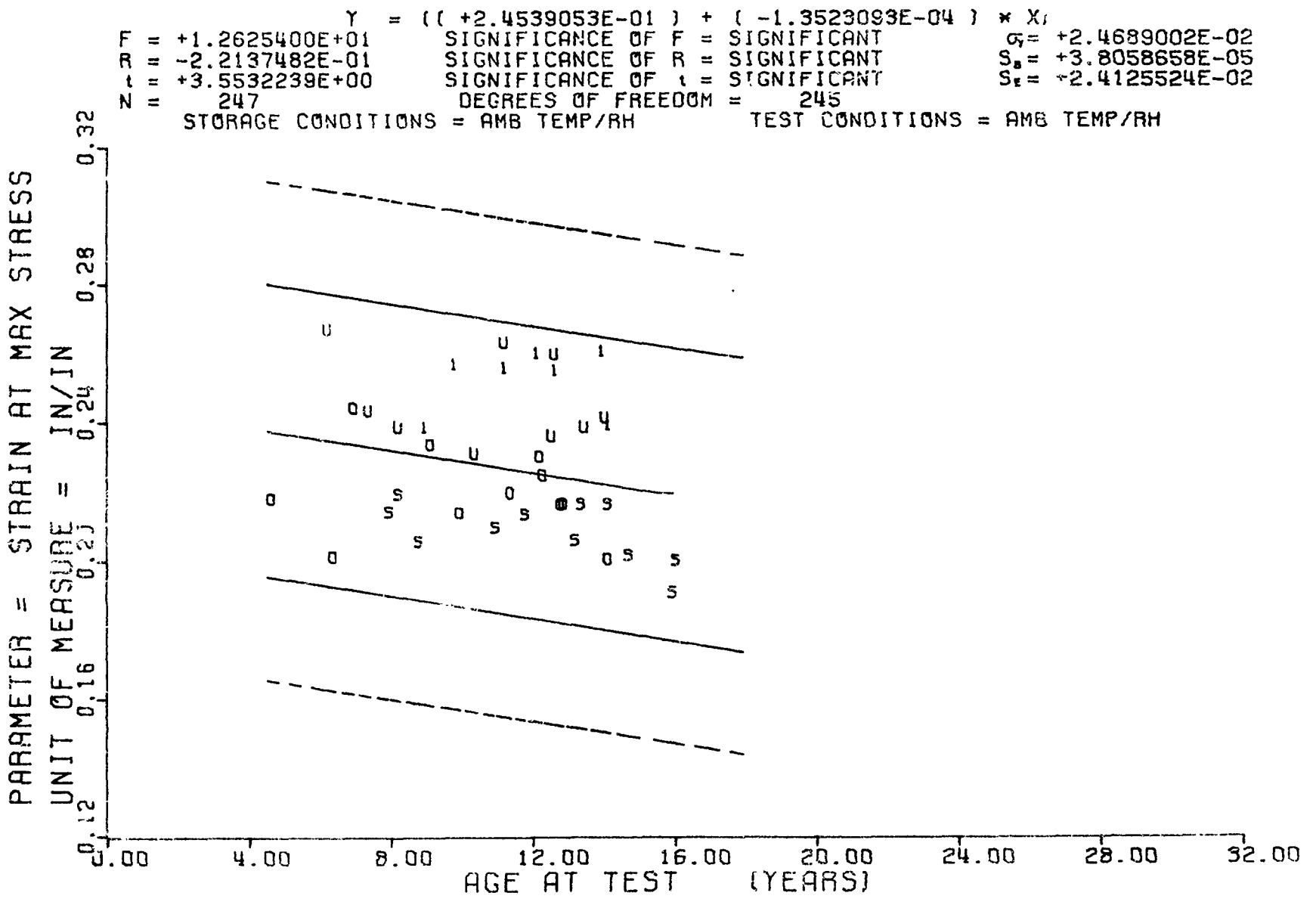
It is recommended that continued testing be conducted on the three dissected motors and UP-7775 block propellant presently being tested and also on those motors selected for testing by Service Engineering. On those motors selected for future dissection, testing will include propellant, casebond and component materials.

*** SAMPLE SIZE SUMMARY ***

AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES
54.0	26	159.0	24
73.0	24	160.0	5
75.0	2	166.0	5
82.0	5	167.0	5
87.0	5	168.0	16
94.0	16	175.0	8
97.0	7	190.0	3
104.0	5	191.0	5
106.0	5		
108.0	5		
116.0	5		
118.0	5		
123.0	4		
130.0	5		
133.0	15		
135.0	3		
140.0	5		
144.0	5		
145.0	3		
146.0	2		
149.0	3		
150.0	10		
152.0	3		
153.0	5		
157.0	3		

STAGE 1 DISSECTED MOTORS,LOW RATE CHS=2.0 IN/MIN,STRAIN MAX STRESS

This sample size summary is applicable for figures 1 thru 4.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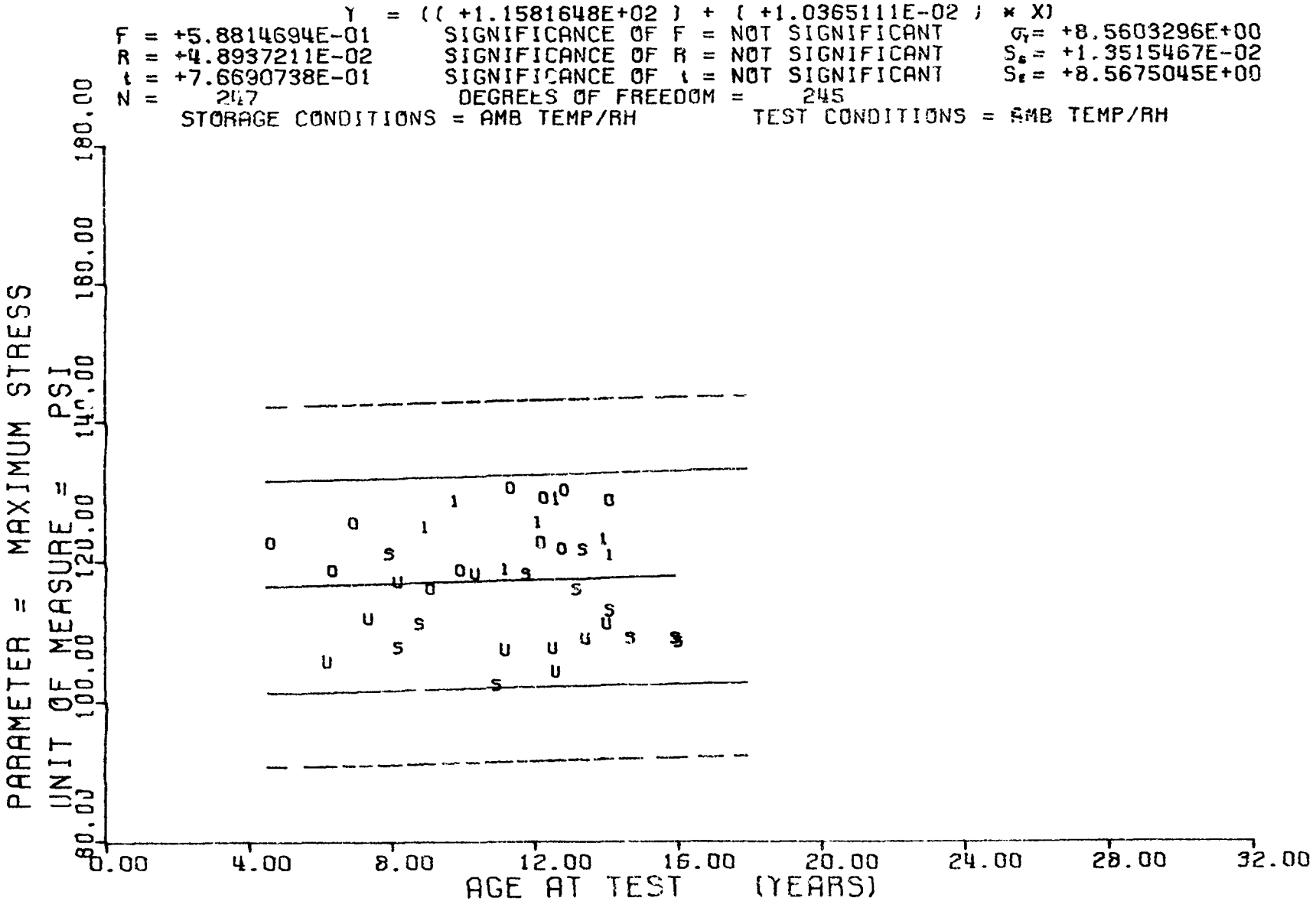
F = +1.2625400E+01 SIGNIFICANCE OF F = SIGNIFICANT σr = +2.4689002E-02
R = -2.2137482E-01 SIGNIFICANCE OF R = SIGNIFICANT Sb = +3.8058658E-05
t = +3.5532239E+00 SIGNIFICANCE OF t = SIGNIFICANT Sr = +2.4125524E-02
N = 247 DEGREES OF FREEDOM = 245
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = STRAIN AT MAX STRESS
UNIT OF MEASURE = IN/IN
0.32
0.28
0.24
0.20
0.16
0.12
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1 DISSECTED MOTORS,LOW RATE CHS=2.0 IN/MIN,STRAIN MAX STRESS

Figure 1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R = +4.8937211E-02 SIGNIFICANCE OF R = NOT SIGNIFICANT S_e = +1.3515467E-02
t = +7.6690738E-01 SIGNIFICANCE OF t = NOT SIGNIFICANT S_ε = +8.5675045E+00
N = 247 DEGREES OF FREEDOM = 245
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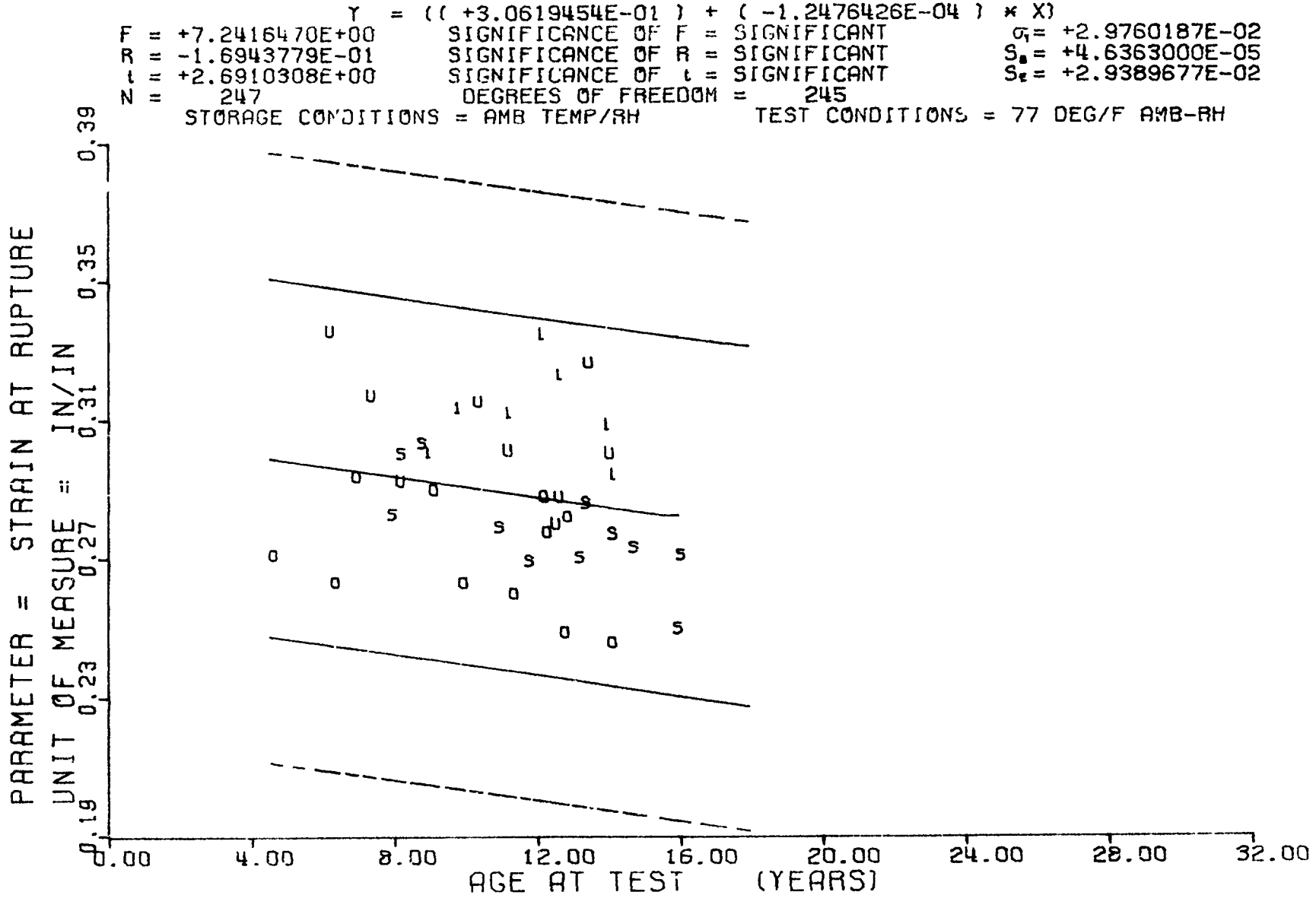
PARAMETER = MAXIMUM STRESS
UNIT OF MEASURE = PSI
80.00
100.00
120.00
140.00
160.00
180.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1 DISSECTED MOTORS,LOW RATE CHS=2.0 IN/MIN,MAXIMUM STRESS

Figure 2


Y = ((+3.0619454E-01) + (-1.2476426E-04) * X)
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R = -1.6943779E-01 SIGNIFICANCE OF R = SIGNIFICANT Sa = +4.6363000E-05
t = +2.6910308E+00 SIGNIFICANCE OF t = SIGNIFICANT Se = +2.9389677E-02
N = 247 DEGREES OF FREEDOM = 245
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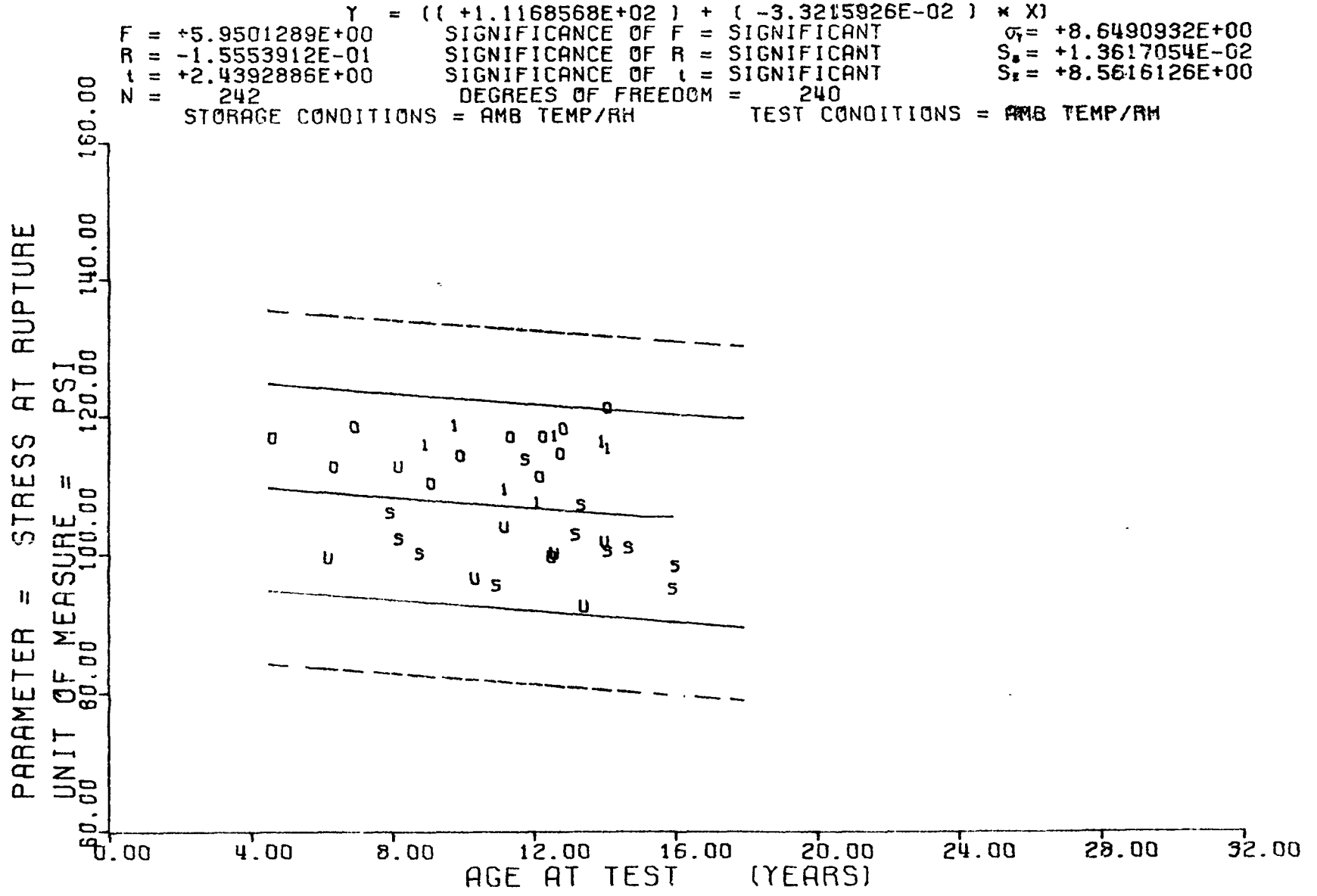
PARAMETER = STRAIN AT RUPTURE
UNIT OF MEASURE = IN/IN
0.39
0.35
0.31
0.27
0.23
0.19
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1 DISSECTED MOTORS,LOW RATE CHS=2.0 IN/MIN,STRAIN AT RUPTURE

Figure 3



STAGE 1 DISSECTED MOTORS,LOW RATE CHS=2.0 IN/MIN,STRESS AT RUPTURE

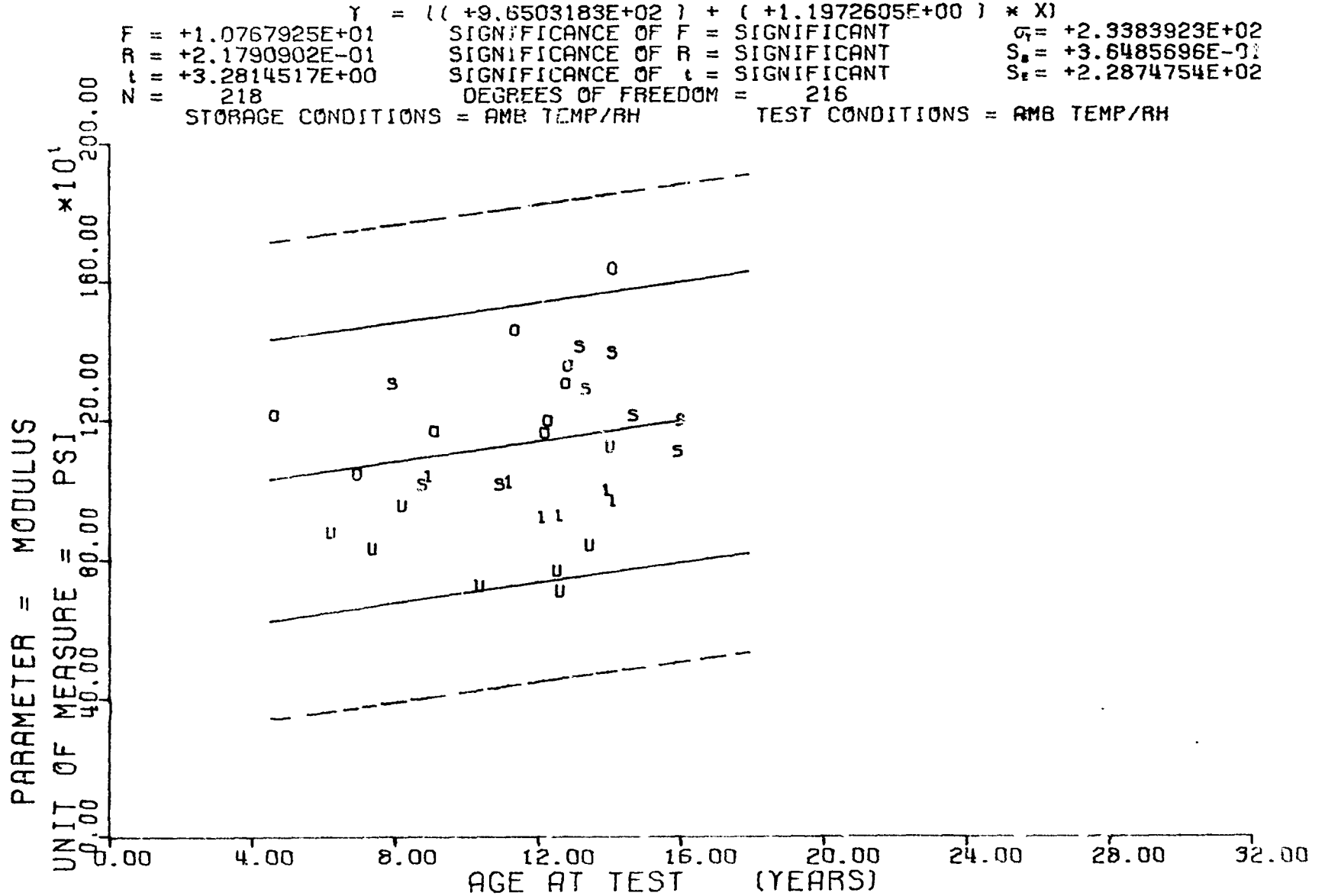
Figure 4

*** SAMPLE SIZE SUMMARY ***

AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES
54.0	26	169.0	16
73.0	24	175.0	8
82.0	5	190.0	3
87.0	5	191.0	5
94.0	16		
97.0	5		
104.0	5		
106.0	5		
108.0	5		
123.0	4		
130.0	5		
133.0	5		
135.0	3		
144.0	5		
145.0	3		
146.0	2		
149.0	3		
150.0	10		
152.0	3		
153.0	5		
157.0	3		
159.0	24		
160.0	5		
166.0	5		
167.0	5		

STAGE 1 DISSECTED MOTORS,LOW RATE CHS=2.0 IN/MIN,MODULUS

This sample size summary is applicable to figure 5



STAGE 1 DISSECTED MOTORS,LOW RATE CHS=2.0 IN/MIN,MODULUS

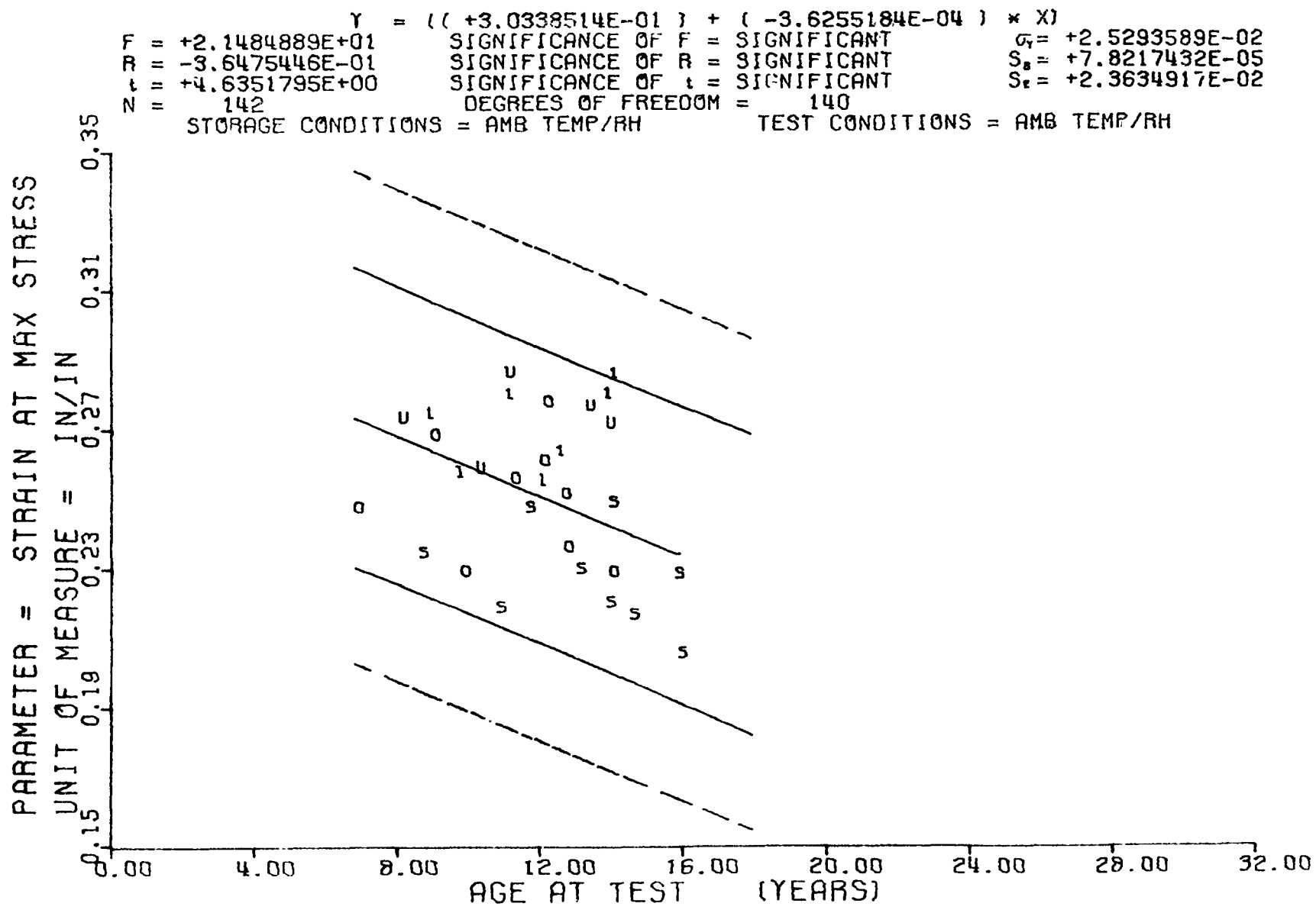
Figure 5

*** SAMPLE SIZE SUMMARY ***

AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES
82.0	2	191.0	5
97.0	5		
104.0	2		
106.0	5		
108.0	5		
116.0	5		
118.0	5		
123.0	5		
130.0	5		
133.0	14		
135.0	3		
140.0	5		
144.0	4		
145.0	3		
146.0	2		
150.0	9		
152.0	3		
153.0	5		
157.0	7		
160.0	5		
166.0	5		
167.0	7		
168.0	15		
175.0	8		
190.0	3		

STAGE 1 DISSECTED MOTORS,LOW RATE CHS=20.0 IN/MIN,STRAIN MAX STRESS

This sample size summary is applicable to figures 6 thru 9


Y = ((+3.0338514E-01) + (-3.6255184E-04) * X)
F = +2.1484889E+01 SIGNIFICANCE OF F = SIGNIFICANT σy= +2.5293589E-02
R = -3.6475446E-01 SIGNIFICANCE OF R = SIGNIFICANT Sb= +7.8217432E-05
t = +4.6351795E+00 SIGNIFICANCE OF t = SIGNIFICANT St= +2.3634917E-02
N = 142 DEGREES OF FREEDOM = 140
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PARAMETER = STRAIN AT MAX STRESS
UNIT OF MEASURE = IN/IN
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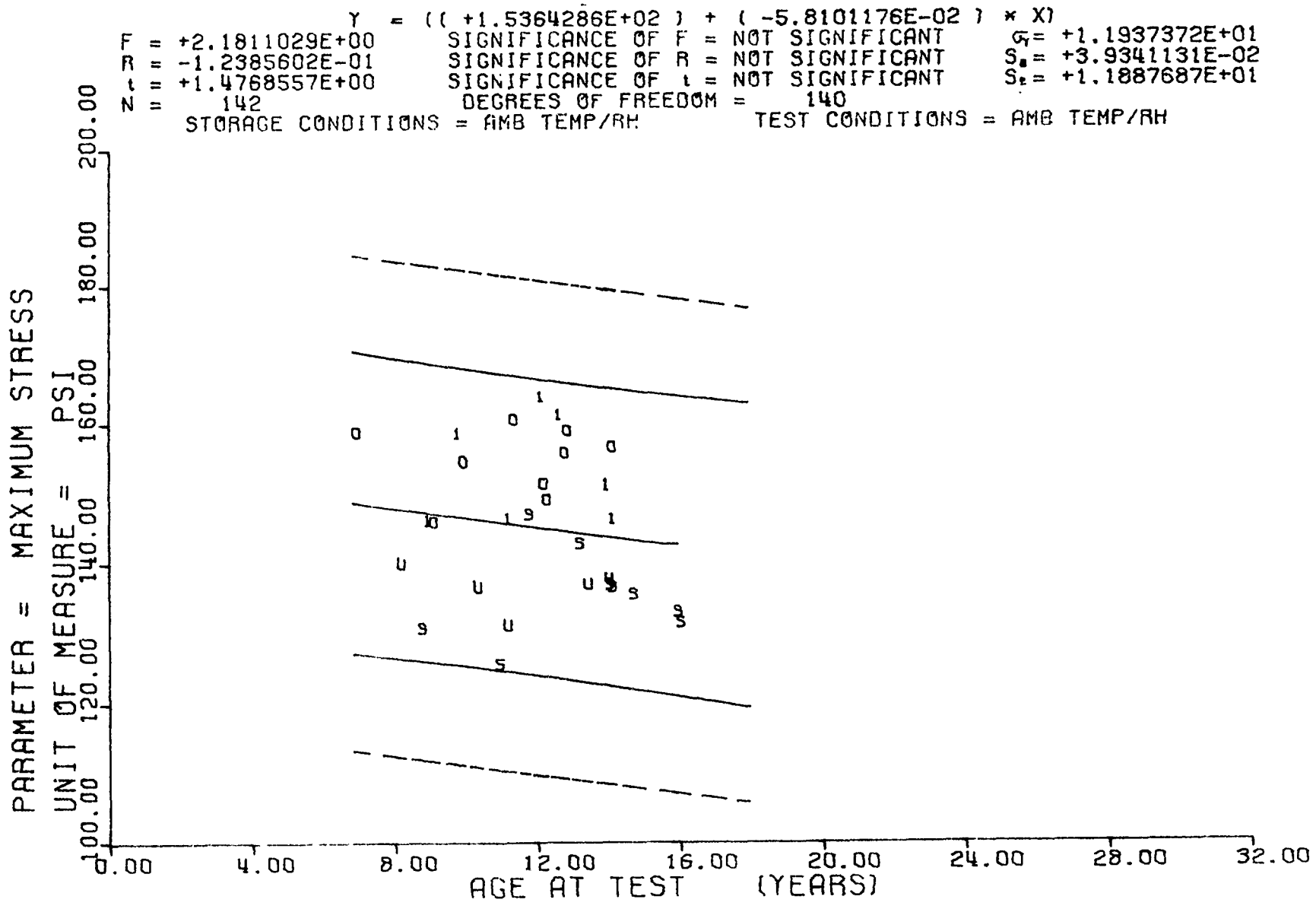
0.31
0.27
0.23
0.19
0.15
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1 DISSECTED MOTORS,LOW RATE CHS=20.0 IN/MIN,STRAIN MAX STRESS

Figure 6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R = -1.2385602E-01 SIGNIFICANCE OF R = NOT SIGNIFICANT Sa = +3.9341131E-02
t = +1.4768557E+00 SIGNIFICANCE OF t = NOT SIGNIFICANT Se = +1.1887687E+01
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200.00
180.00
160.00
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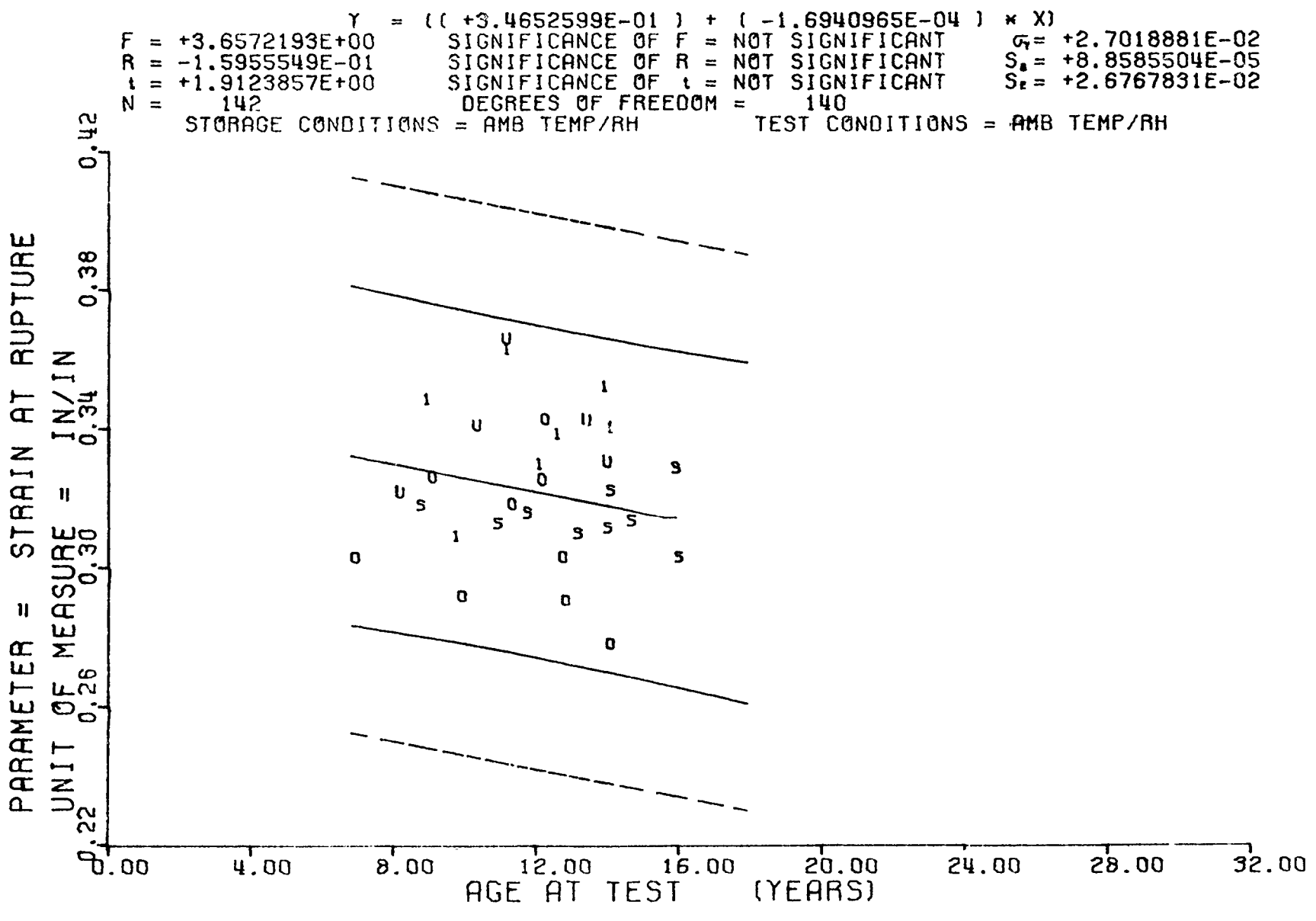
120.00
100.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1 DISSECTED MOTORS,LOW RATE CHS=20.0 IN/MIN,MAXIMUM STRESS

Figure 7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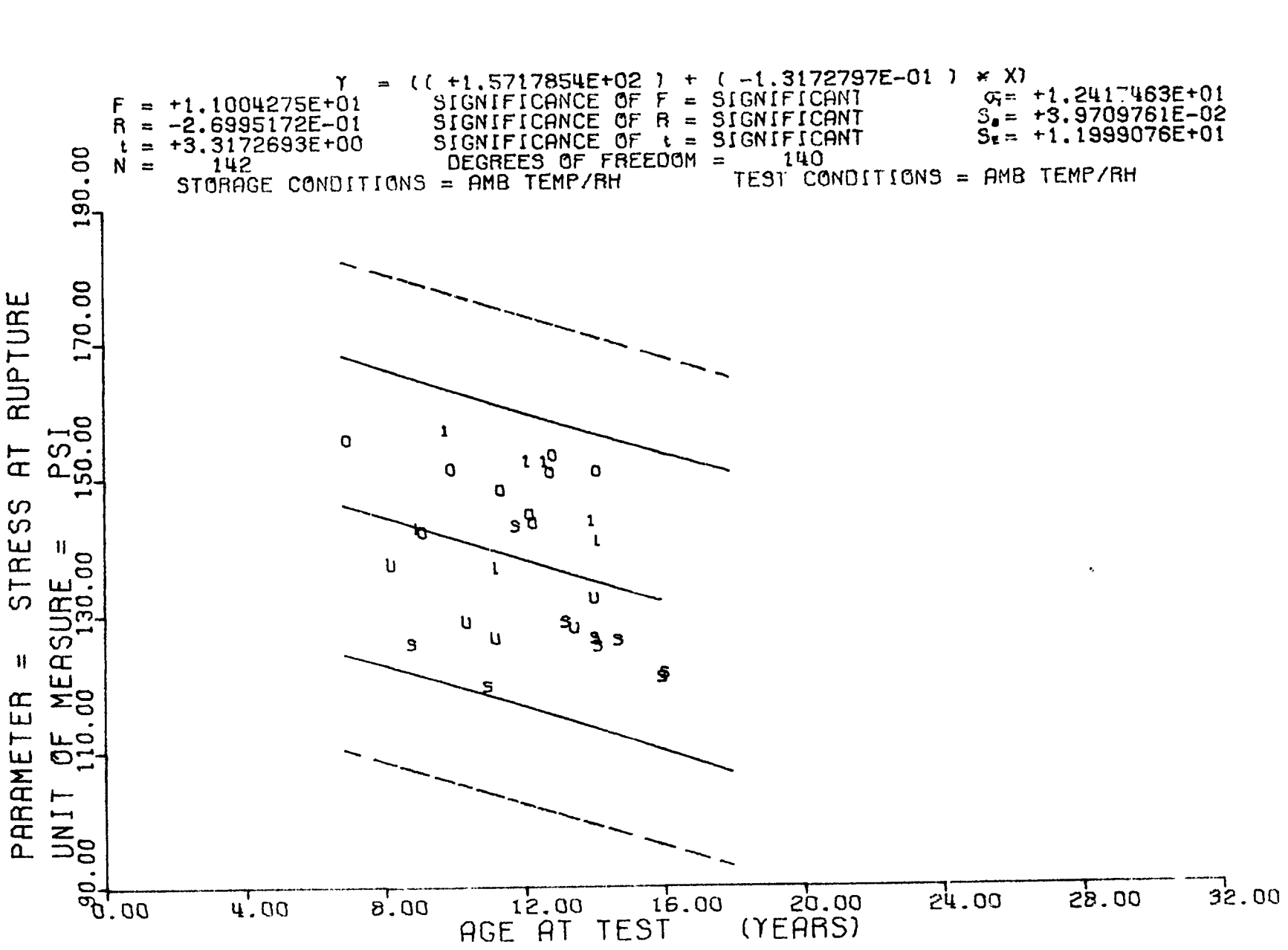
0.26
0.22
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1 DISSECTED MOTORS,LOW RATE CHS=20.0 IN/MIN,STRAIN AT RUPTURE

Figure 8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F = +1.1004275E+01 SIGNIFICANCE OF F = SIGNIFICANT
R = -2.6995172E-01 SIGNIFICANCE OF R = SIGNIFICANT
t = +3.3172693E+00 SIGNIFICANCE OF t = SIGNIFICANT
N = 142 DEGREES OF FREEDOM = 140
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = STRESS AT RUPTURE
UNIT OF MEASURE = PSI
90.00
110.00
130.00
150.00
170.00
190.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1 DISSECTED MOTORS,LOW RATE CHS=20.0 IN/MIN,STRESS AT RUPTURE

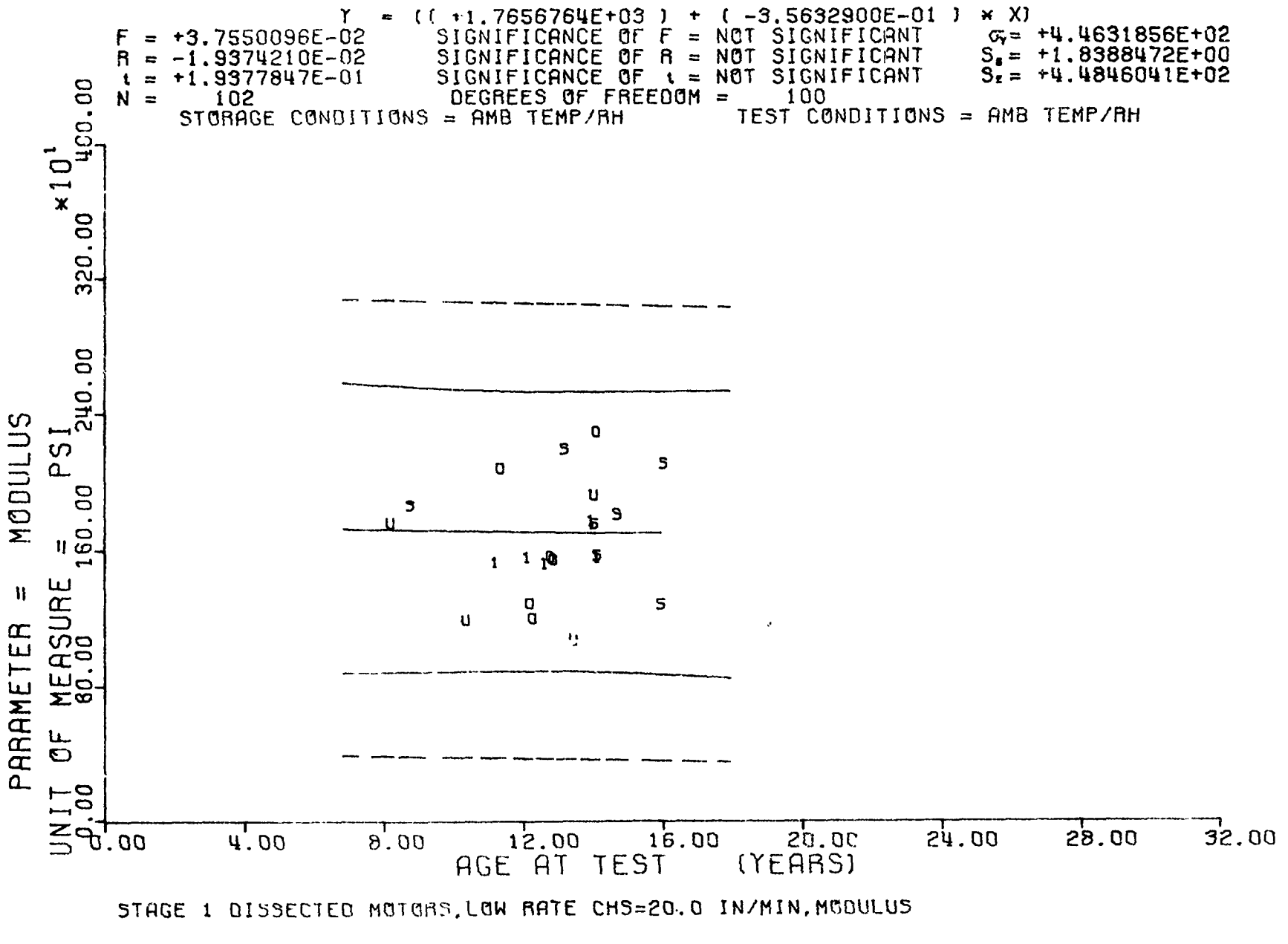
Figure 9

*** SAMPLE SIZE SUMMARY ***

AGE (MONTHS)	NR SAMPLES
82.0	2
97.0	5
104.0	2
123.0	5
133.0	4
135.0	3
144.0	4
145.0	3
146.0	2
150.0	9
152.0	3
153.0	5
157.0	7
160.0	5
166.0	5
167.0	7
168.0	15
175.0	8
190.0	3
191.0	5

STAGE 1 DISSECTED MOTORS,LOW RATE CHS=20.0 IN/MIN,MODULUS

This sample size summary is applicable to figure 10



STAGE 1 DISSECTED MOTORS,LOW RATE CHS=20.0 IN/MIN,MODULUS

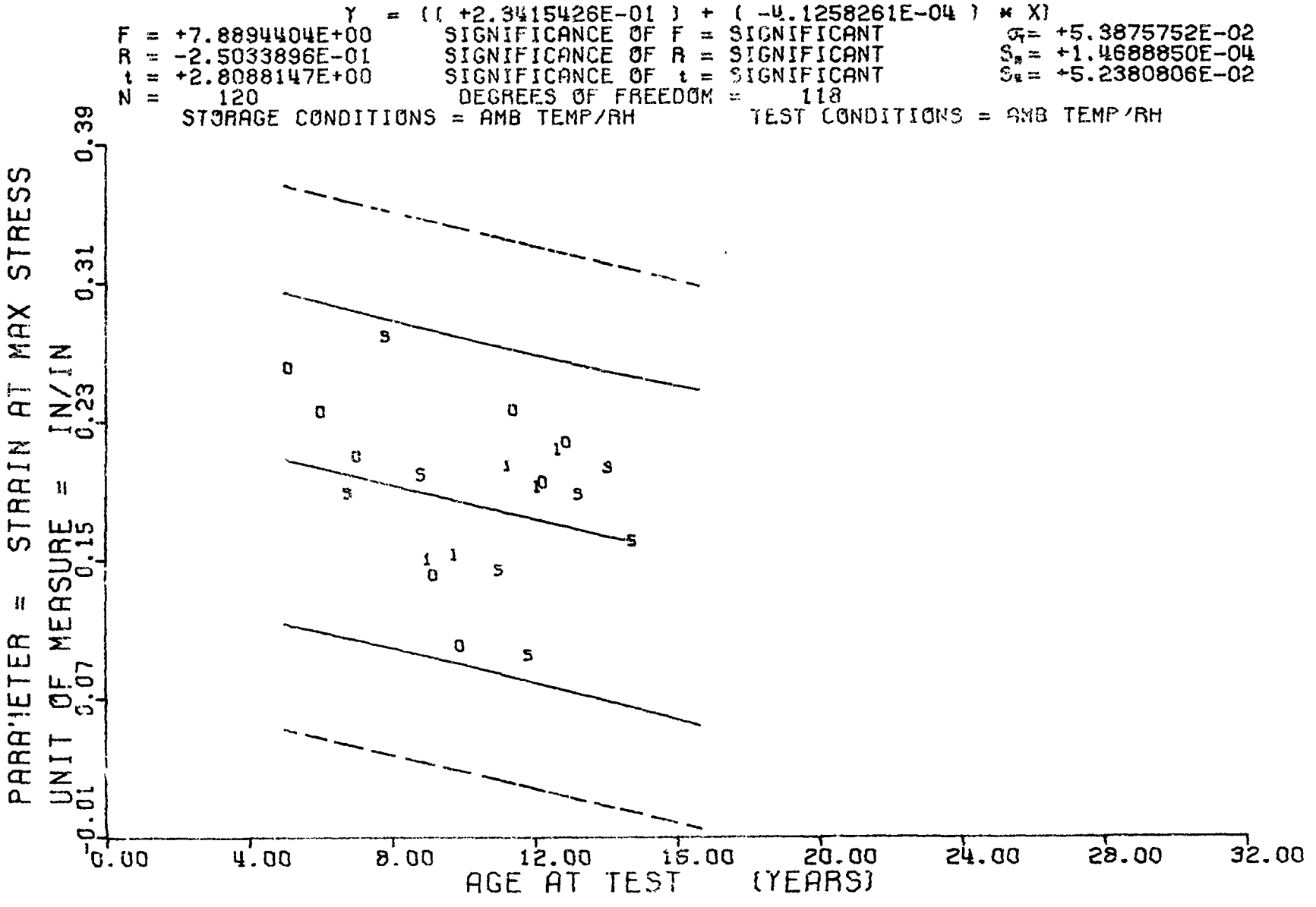
Figure 10

*** SAMPLE SIZE SUMMARY ***

AGE (MONTHS)	NR SAMPLES
60.0	6
71.0	4
80.0	16
83.0	5
93.0	6
105.0	6
107.0	5
109.0	5
116.0	6
118.0	6
131.0	5
134.0	5
136.0	4
141.0	6
144.0	5
146.0	5
151.0	5
154.0	5
158.0	5
168.0	5
176.0	5

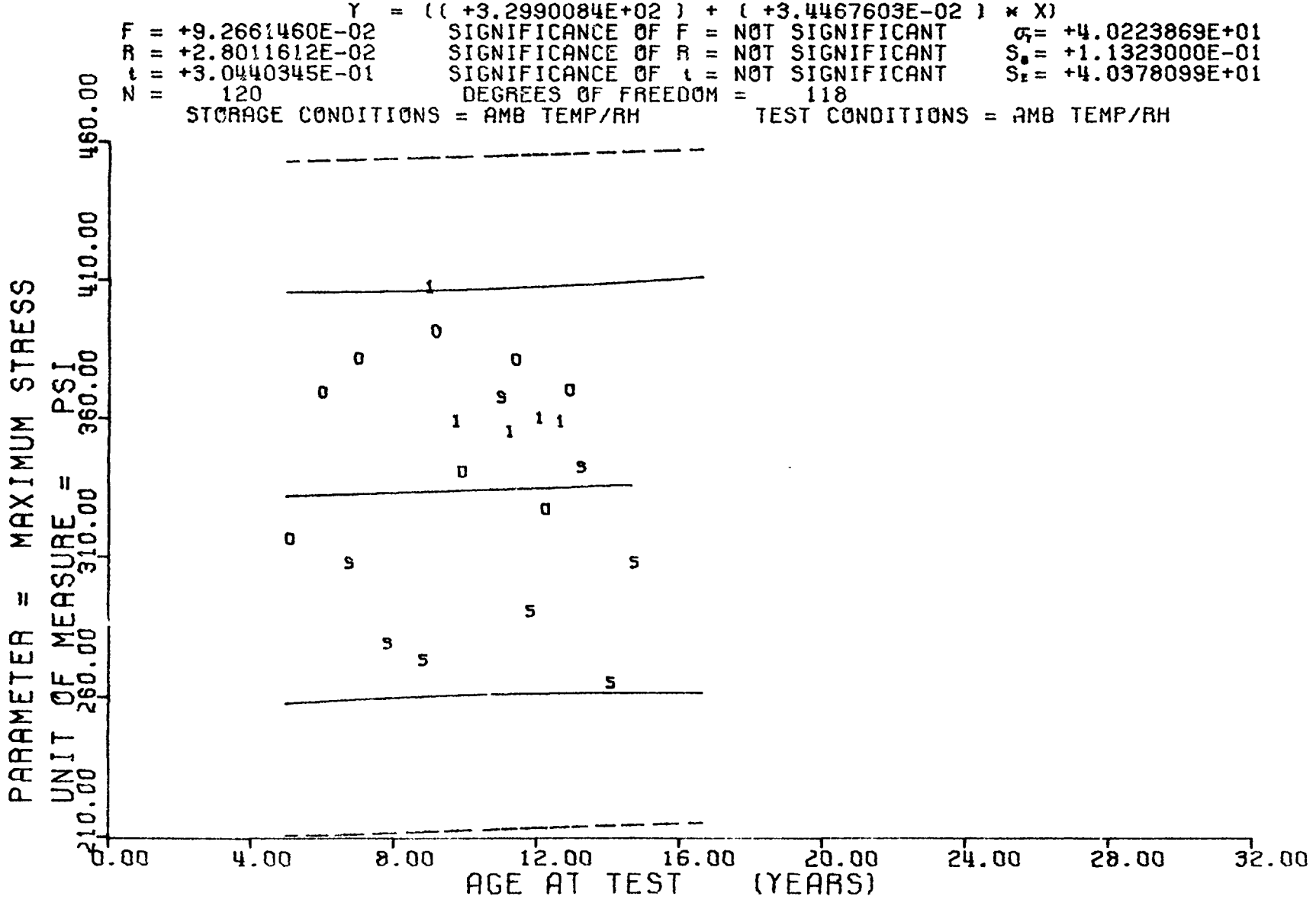
STAGE 1 DISSECTED MOTORS,HIGH RATE CHS=1750 IN/MIN,STRAIN MAX STRESS

This sample size summary is applicable to figures 11 thru 15



STAGE 1 DISSECTED MOTORS, HIGH RATE CHS=1750 IN/MIN, STRAIN MAX STRESS

Figure 11



STAGE 1 DISSECTED MOTORS,HIGH RATE CHS=1750 IN/MIN,MAXIMUM STRESS

Figure 12

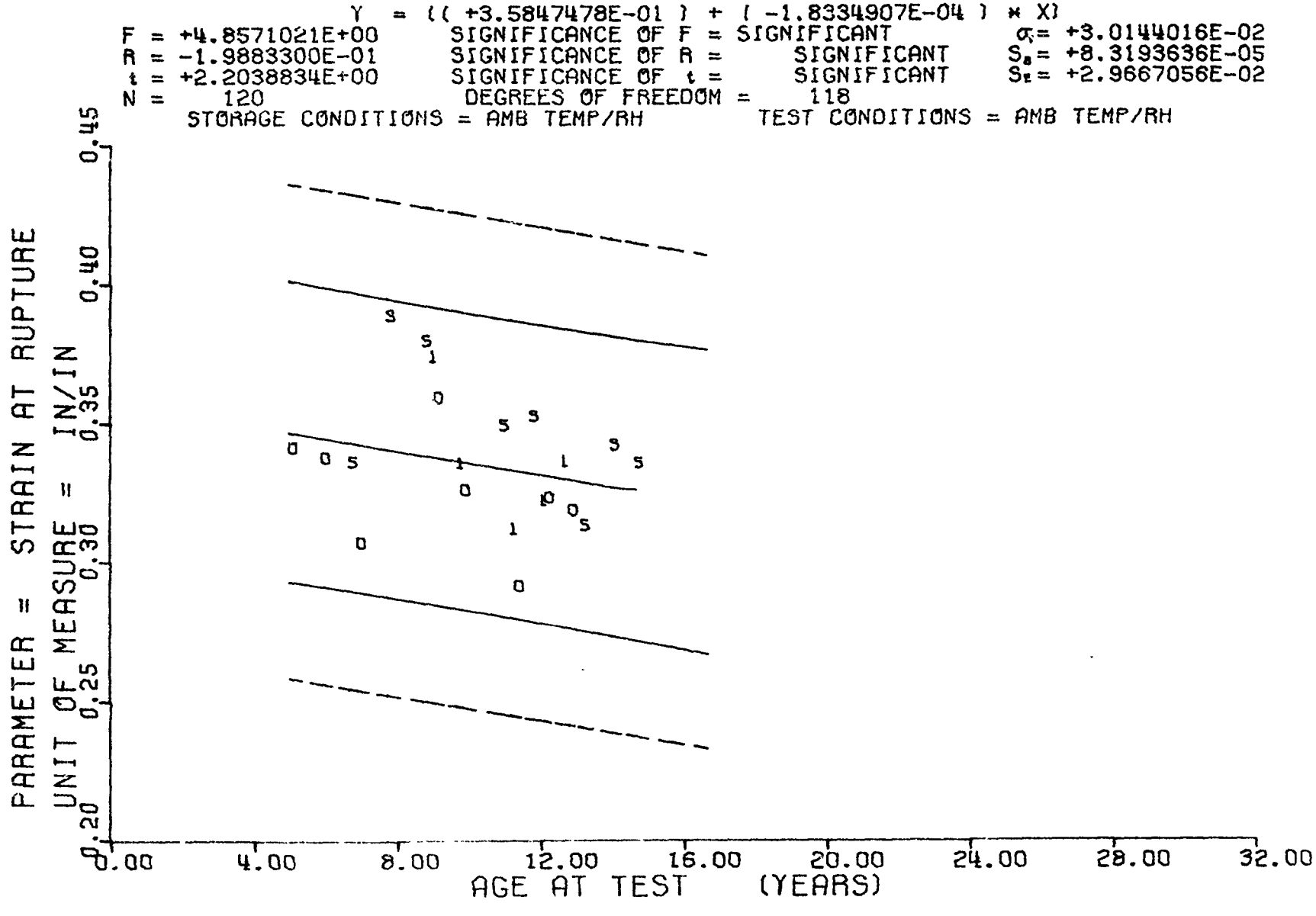

Y = ((+3.5847478E-01) + (-1.8334907E-04) * X)
F = +4.8571021E+00 SIGNIFICANCE OF F = SIGNIFICANT σ = +3.0144016E-02
R = -1.9883300E-01 SIGNIFICANCE OF R = SIGNIFICANT Sa = +8.3193636E-05
t = +2.2038834E+00 SIGNIFICANCE OF t = SIGNIFICANT Sε = +2.9667056E-02
N = 120 DEGREES OF FREEDOM = 118
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = STRAIN AT RUPTURE
UNIT OF MEASURE = IN/IN
0.45
0.40
0.35
0.30
0.25
0.20
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1 DISSECTED MOTORS,HIGH RATE CHS=1750 IN/MIN,STRAIN AT RUPTURE

Figure 13

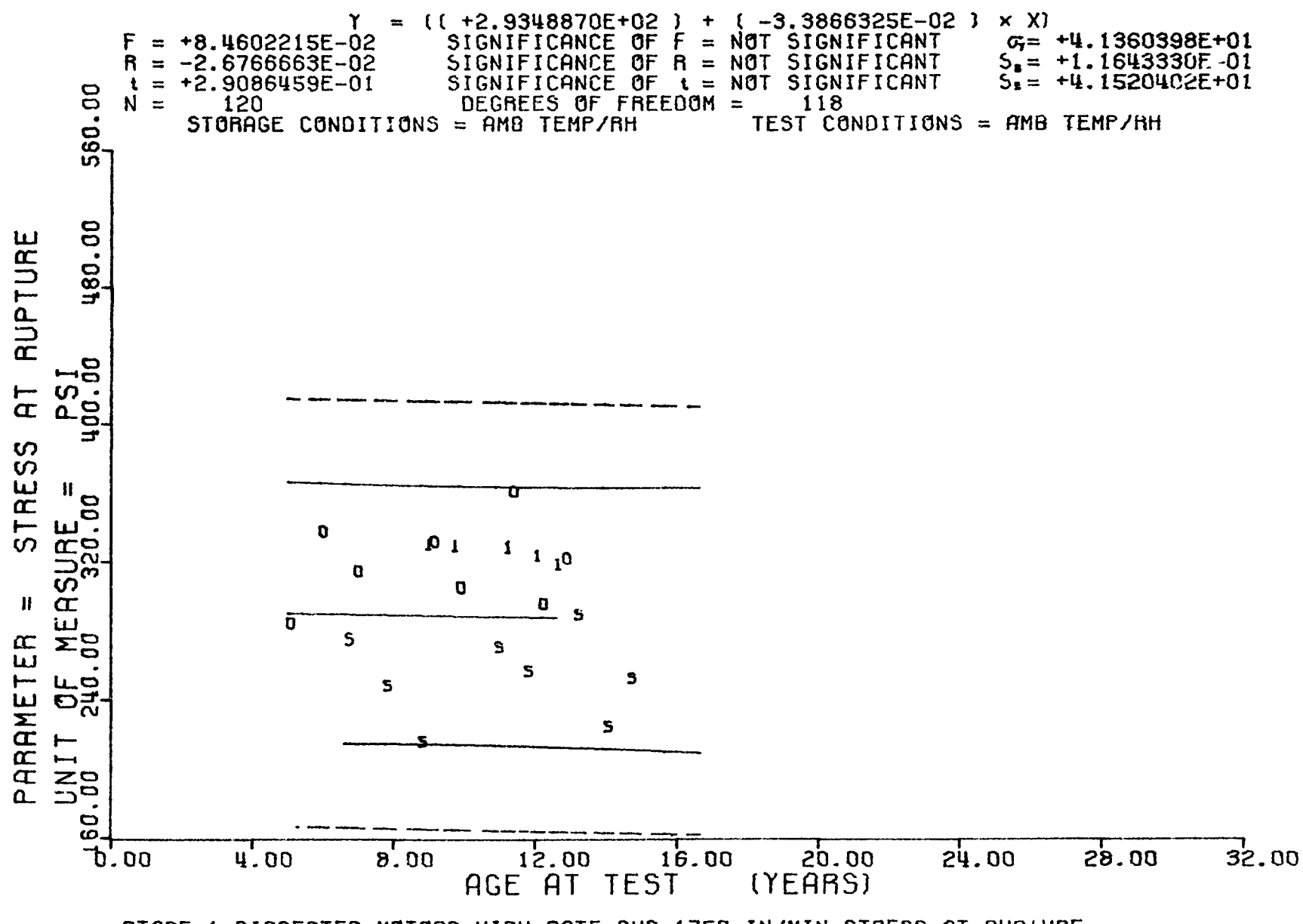
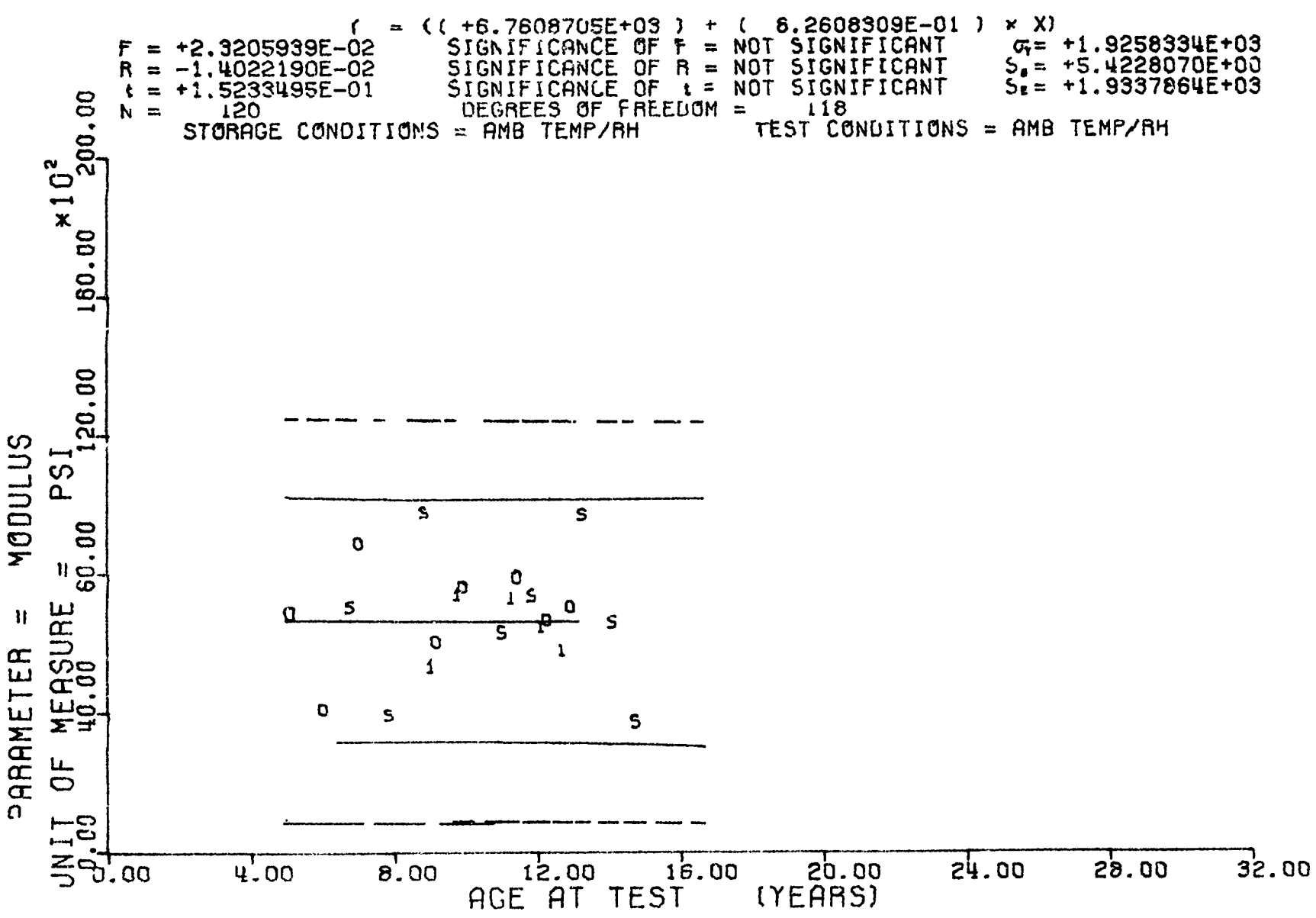

Y = ((+2.9348870E+02) + (-3.3866325E-02) × X)
F = +8.4602215E-02 SIGNIFICANCE OF F = NOT SIGNIFICANT σ = +4.1360398E+01
R = -2.6766663E-02 SIGNIFICANCE OF R = NOT SIGNIFICANT S = +1.1643330E-01
t = +2.9086459E-01 SIGNIFICANCE OF t = NOT SIGNIFICANT S = +4.1520402E+01
N = 120 DEGREES OF FREEDOM = 118
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = STRESS AT RUPTURE
UNIT OF MEASURE = PSI
560.00
480.00
400.00
320.00
240.00
160.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1 DISSECTED MOTORS,HIGH RATE CHS=1750 IN/MIN,STRESS AT RUPTURE

Figure 14



STAGE 1 DISSECTED MOTORS, HIGH RATE CHS=1750 IN/MIN, MODULUS

Figure 15

*** SAMPLE SIZE SUMMARY ***

AGE (MONTHS)	NR SAMPLES
71.0	2
72.0	8
83.0	2
93.0	2
105.0	2
108.0	2
110.0	2
132.0	2
134.0	4
136.0	2
144.0	2
146.0	2
151.0	3
153.0	3
158.0	2
168.0	2
175.0	3

DISSECTED TP-H1011,H.R.TRIAXIAL CHS=1750 IN/MIN,600 PSI,STRAIN MAX STRESS

This sample size summary is applicable to figures 16 thru 20

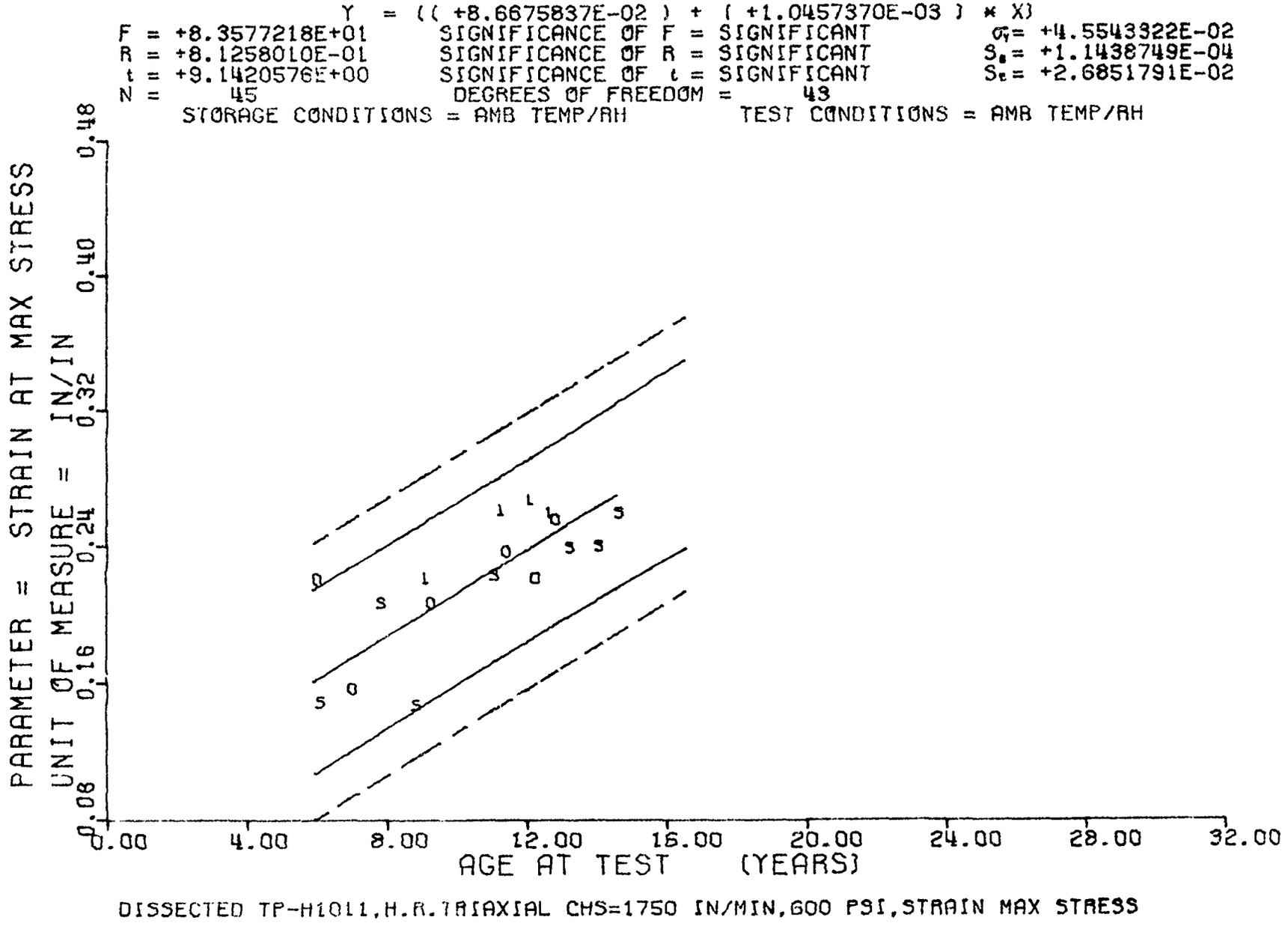

Y = ((+8.6675837E-02) + (+1.0457370E-03) * X)
F = +8.3577218E+01 SIGNIFICANCE OF F = SIGNIFICANT σr= +4.5543322E-02
R = +8.1258010E-01 SIGNIFICANCE OF R = SIGNIFICANT Sa= +1.1438749E-04
t = +9.1420576E+00 SIGNIFICANCE OF t = SIGNIFICANT St= +2.6851791E-02
N = 45 DEGREES OF FREEDOM = 43
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = STRAIN AT MAX STRESS
UNIT OF MEASURE = IN/IN
0.08
0.16
0.24
0.32
0.40
0.48
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
DISSECTED TP-H1011,H.R.TRIAXIAL CHS=1750 IN/MIN,600 PSI,STRAIN MAX STRESS

Figure 16

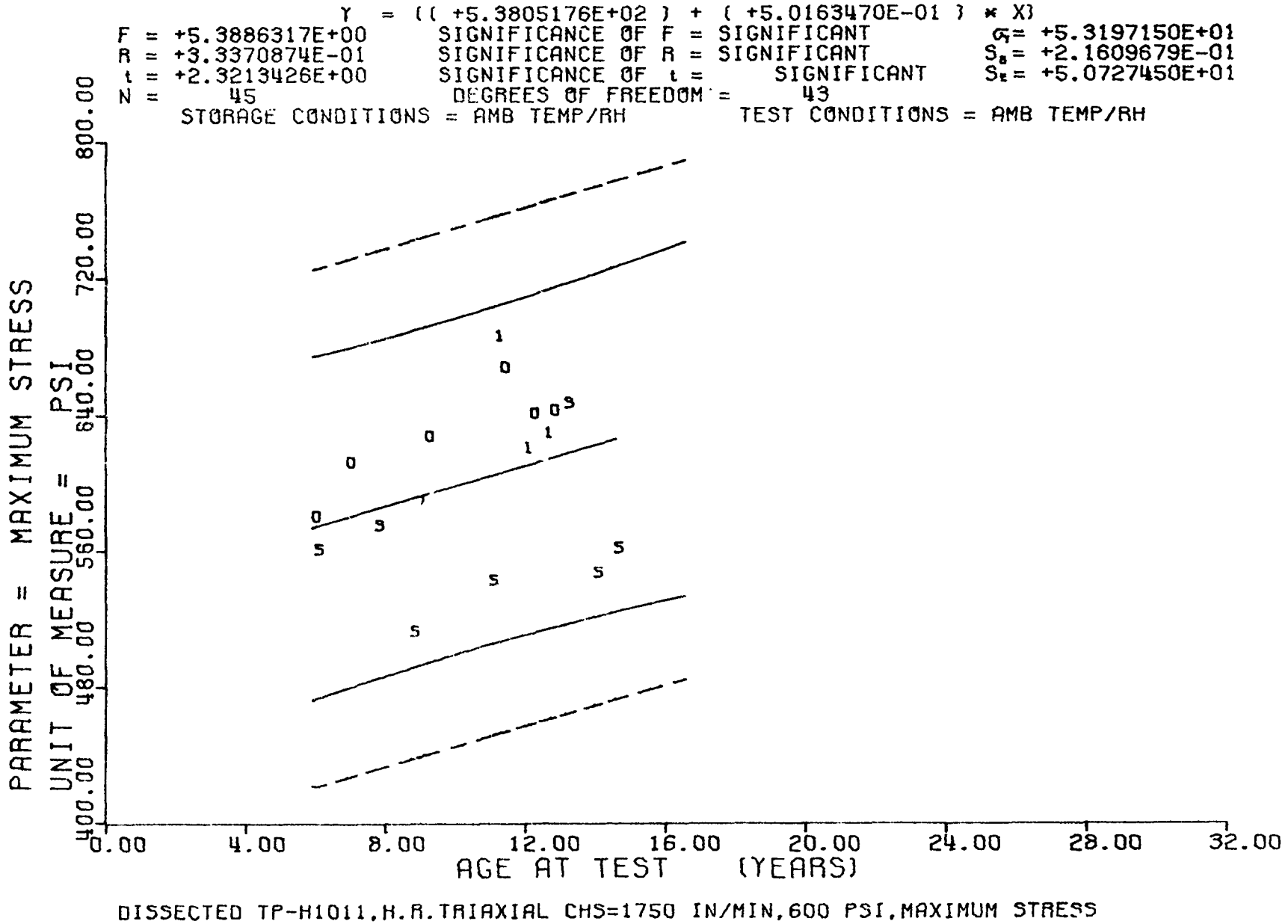

Y = ((+5.3805176E+02) + (+5.0163470E-01) * X)
F = +5.3886317E+00 SIGNIFICANCE OF F = SIGNIFICANT σ = +5.3197150E+01
R = +3.3370874E-01 SIGNIFICANCE OF R = SIGNIFICANT S_a = +2.1609679E-01
t = +2.3213426E+00 SIGNIFICANCE OF t = SIGNIFICANT S_t = +5.0727450E+01
N = 45 DEGREES OF FREEDOM = 43
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = MAXIMUM STRESS
UNIT OF MEASURE = PSI
800.00
720.00
640.00
560.00
480.00
400.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
DISSECTED TP-H1011,H.R.TRIAXIAL CHS=1750 IN/MIN,600 PSI,MAXIMUM STRESS

Figure 17

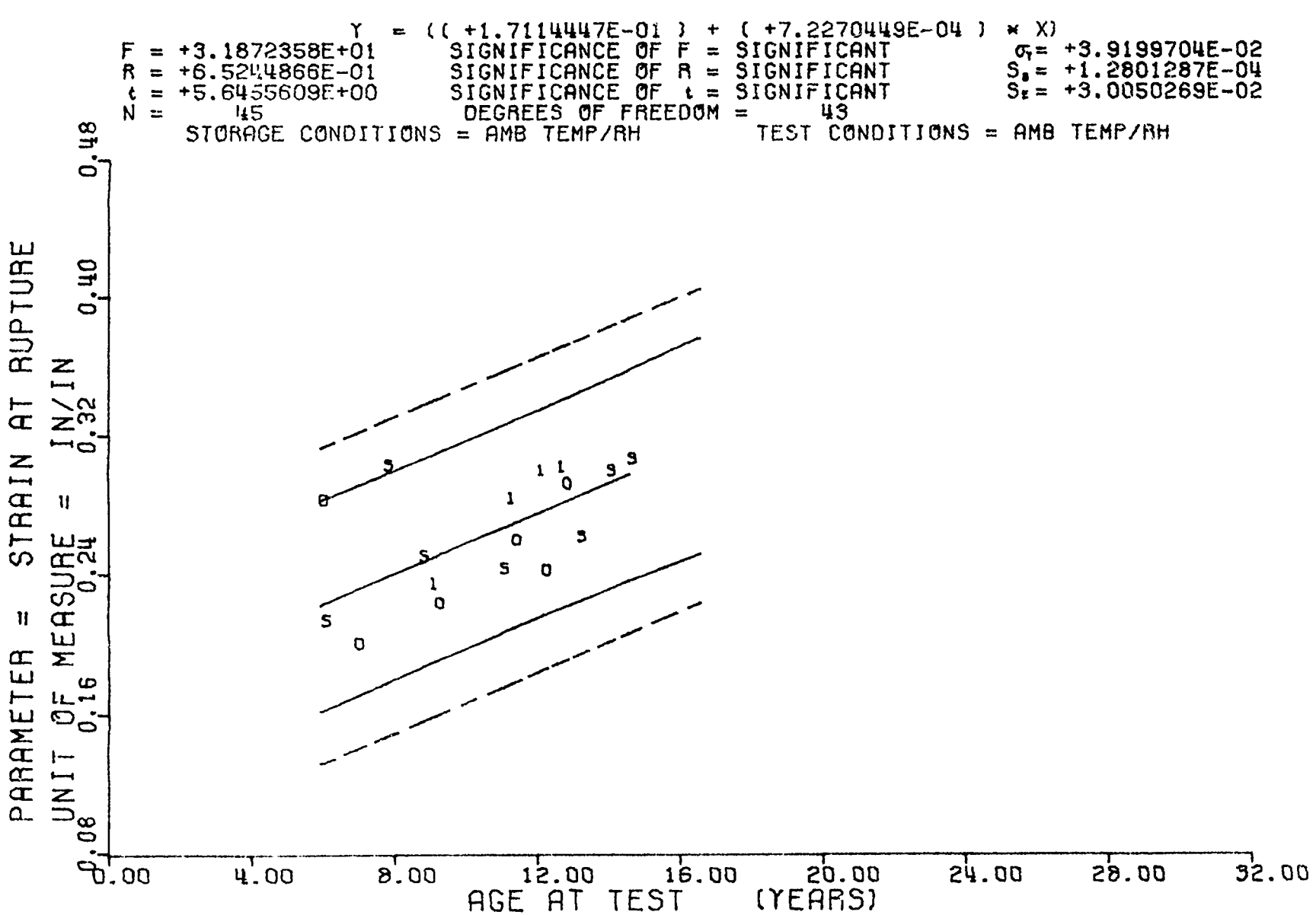

Y = ((+1.7114447E-01) + (+7.2270449E-04) * X)
F = +3.1872358E+01 SIGNIFICANCE OF F = SIGNIFICANT σr = +3.9199704E-02
R = +6.5244866E-01 SIGNIFICANCE OF R = SIGNIFICANT Se = +1.2801287E-04
t = +5.6455609E+00 SIGNIFICANCE OF t = SIGNIFICANT St = +3.0050269E-02
N = 45 DEGREES OF FREEDOM = 43
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = STRAIN AT RUPTURE
UNIT OF MEASURE = IN/IN
0.08
0.16
0.24
0.32
0.40
0.48
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
DISSECTED TP-H1011,H.R.TRIAXIAL CHS=1750 IN/MIN,600 PSI,STRAIN AT RUPTURE

Figure 18

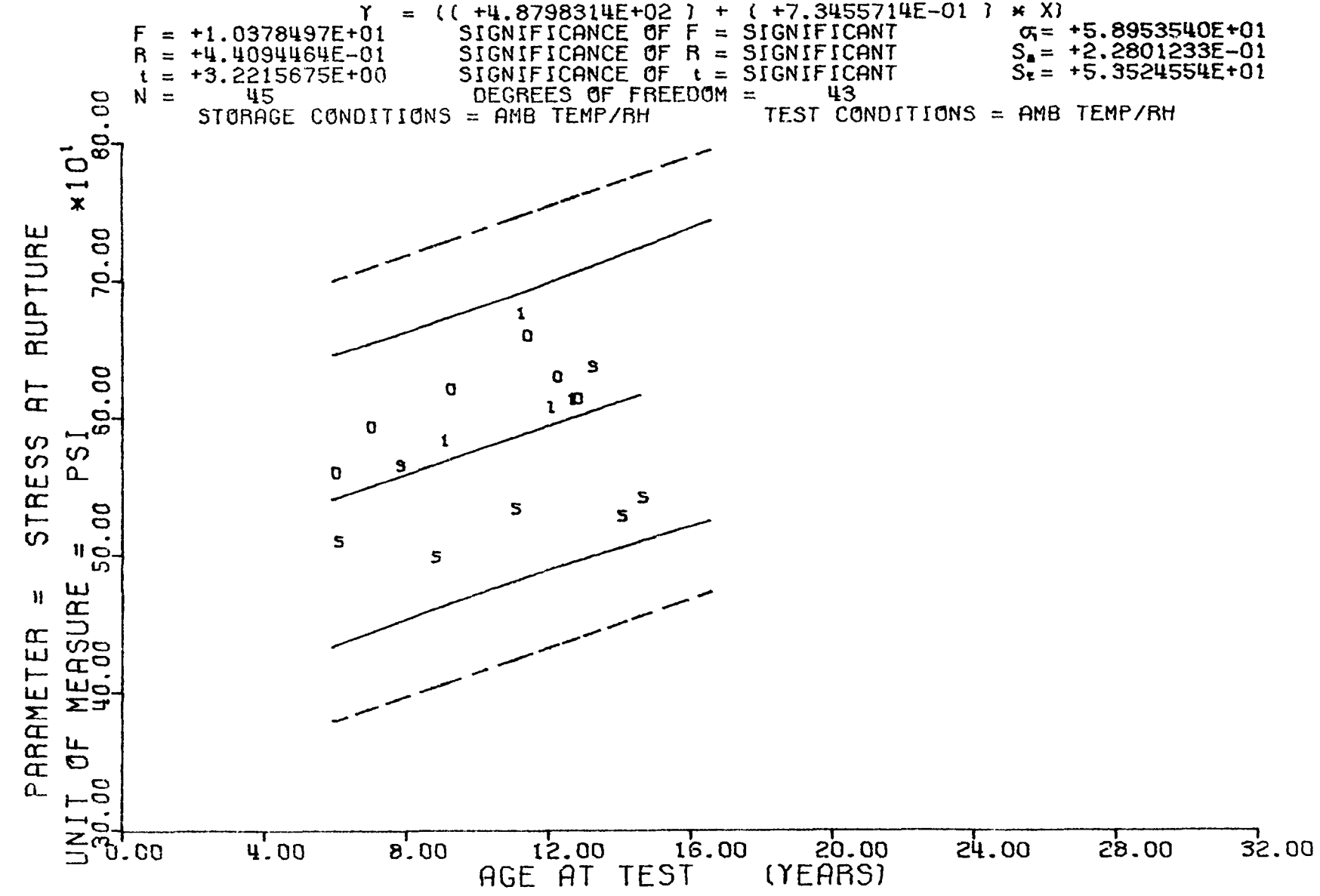
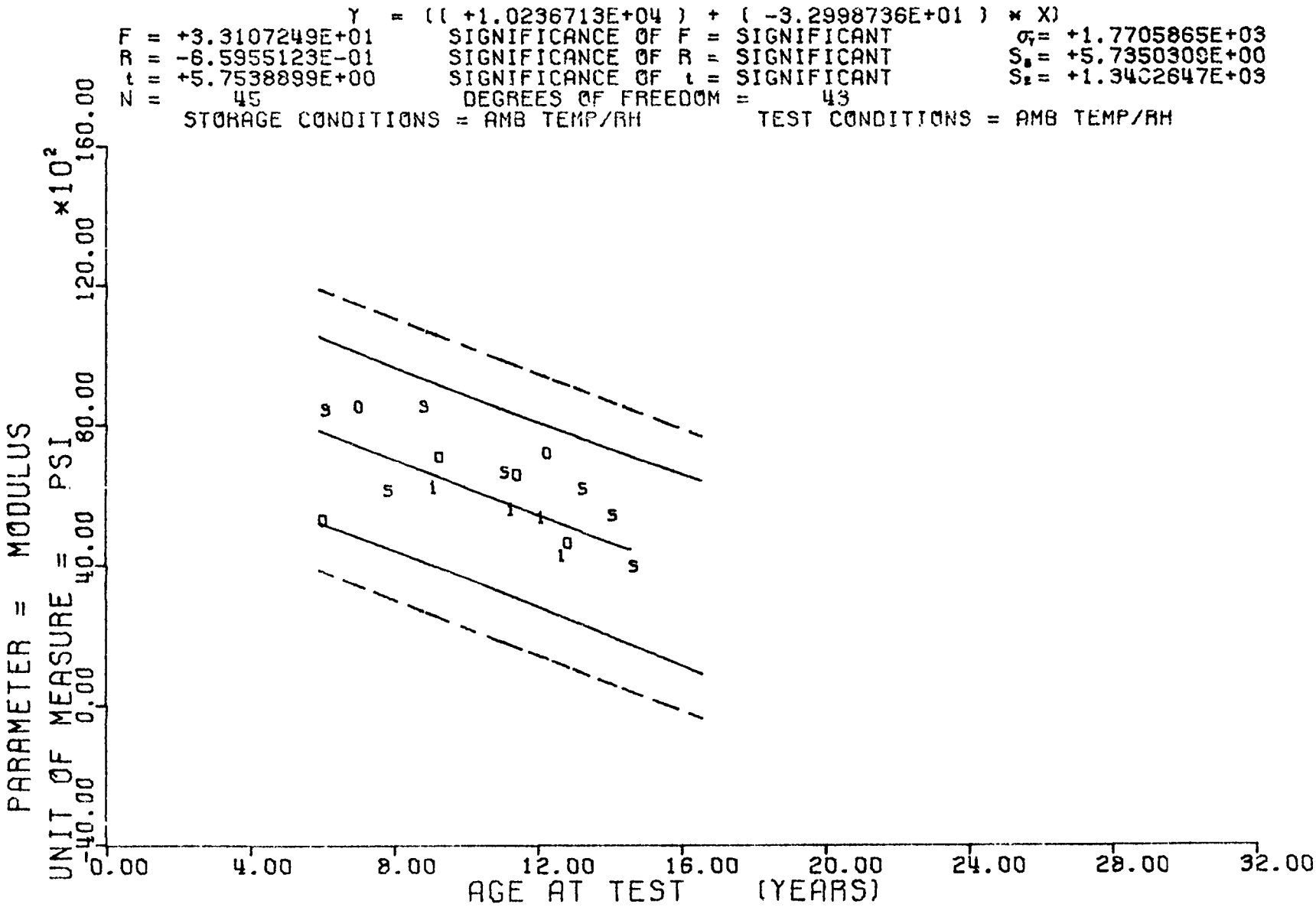

Y = ((+4.8798314E+02) + (+7.3455714E-01) * X)
F = +1.0378497E+01 SIGNIFICANCE OF F = SIGNIFICANT σ = +5.8953540E+01
R = +4.4094464E-01 SIGNIFICANCE OF R = SIGNIFICANT Sa = +2.2801233E-01
t = +3.2215675E+00 SIGNIFICANCE OF t = SIGNIFICANT St = +5.3524554E+01
N = 45 DEGREES OF FREEDOM = 43
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = STRESS AT RUPTURE
UNIT OF MEASURE = PSI *10¹
80.00
70.00
60.00
50.00
40.00
30.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
DISSECTED TP-H1011,H.R.TRIAXIAL CHS=1750 IN/MIN,600 PSI,STRESS AT RUPTURE

Figure 19



DISSECTED TP-H1011,H.R.TRIAXIAL CHS=1750 IN/MIN,600 PSI,MODULUS

Figure 20

*** SAMPLE SIZE SUMMARY ***

AGE (MONTHS)	NR SAMPLES
80.0	27
94.0	2
104.0	10
113.0	12
116.0	12
141.0	11
154.0	9
156.0	22
166.0	9
178.0	8
189.0	11

CASEBOND TENSILE, STAGE 1 DISSECTED, CHS 0.2, CSA 0.75

This sample size summary is applicable to figure 21

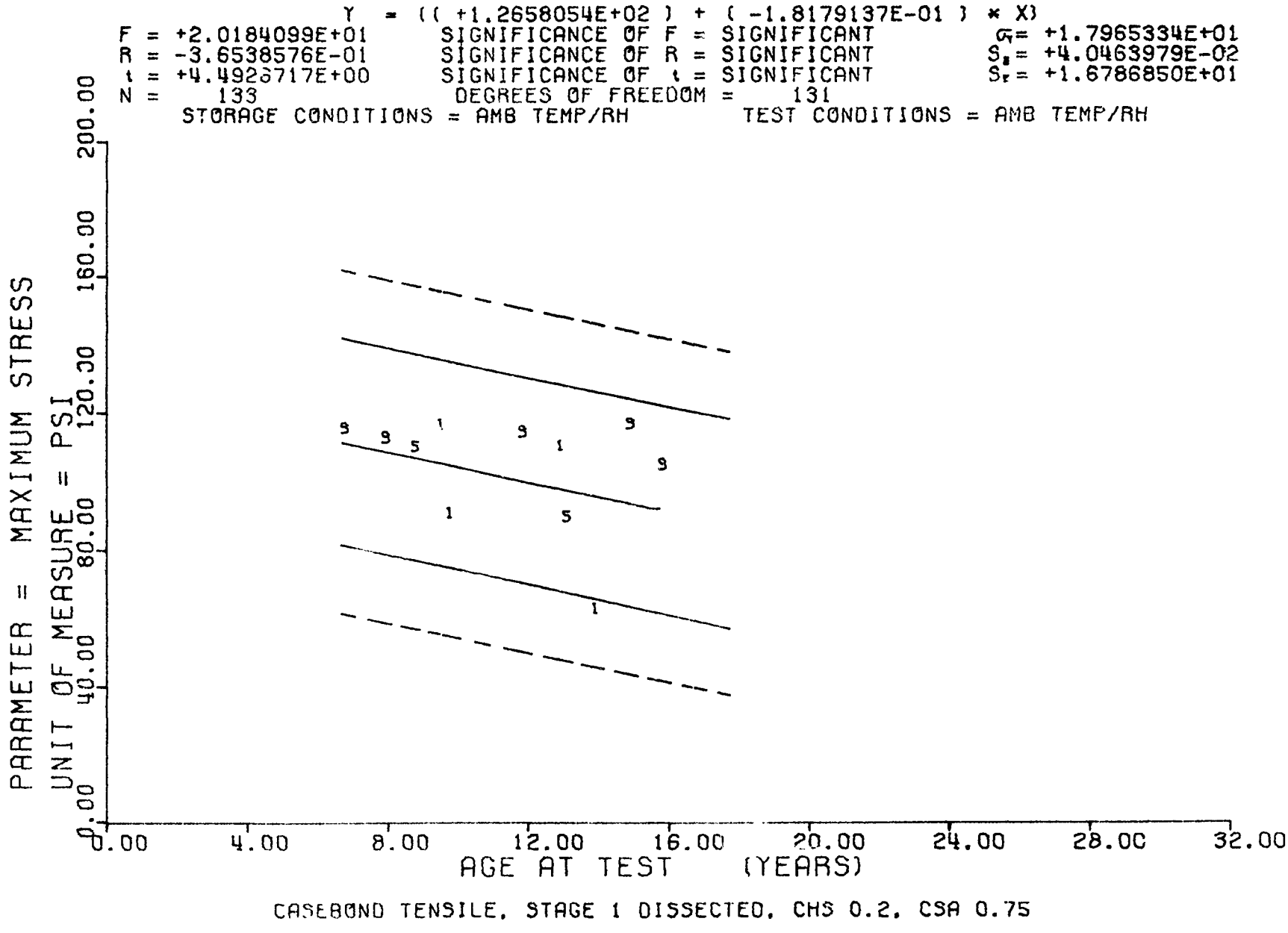

Y = ((+1.2658054E+02) + (-1.8179137E-01) * X)
F = +2.0184099E+01 SIGNIFICANCE OF F = SIGNIFICANT σ = +1.7965334E+01
R = -3.6538576E-01 SIGNIFICANCE OF R = SIGNIFICANT S_a = +4.0463979E-02
t = +4.4928717E+00 SIGNIFICANCE OF t = SIGNIFICANT S_r = +1.6786850E+01
N = 133 DEGREES OF FREEDOM = 131
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = MAXIMUM STRESS
UNIT OF MEASURE = PSI
0.00
40.00
80.00
120.00
160.00
200.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
CASEBOND TENSILE, STAGE 1 DISSECTED, CHS 0.2, CSA 0.75

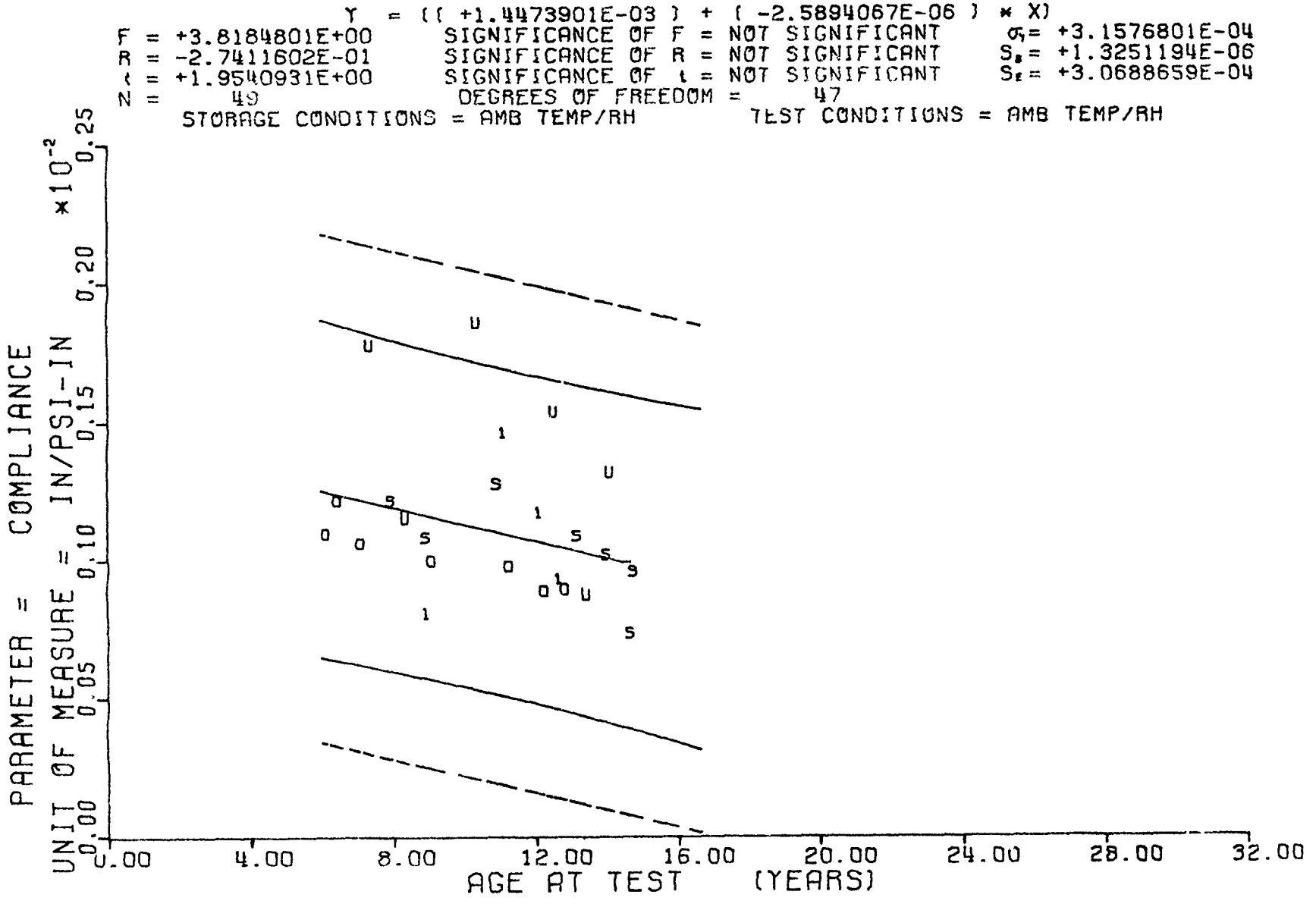
Figure 21

*** SAMPLE SIZE SUMMARY ***

AGE (MONTHS)	NR SAMPLES
72.0	2
76.0	3
84.0	2
87.0	2
94.0	2
99.0	2
106.0	3
108.0	1
123.0	1
130.0	1
132.0	2
134.0	2
144.0	2
146.0	2
149.0	2
151.0	4
153.0	3
157.0	1
160.0	2
167.0	4
168.0	3
175.0	2
176.0	1

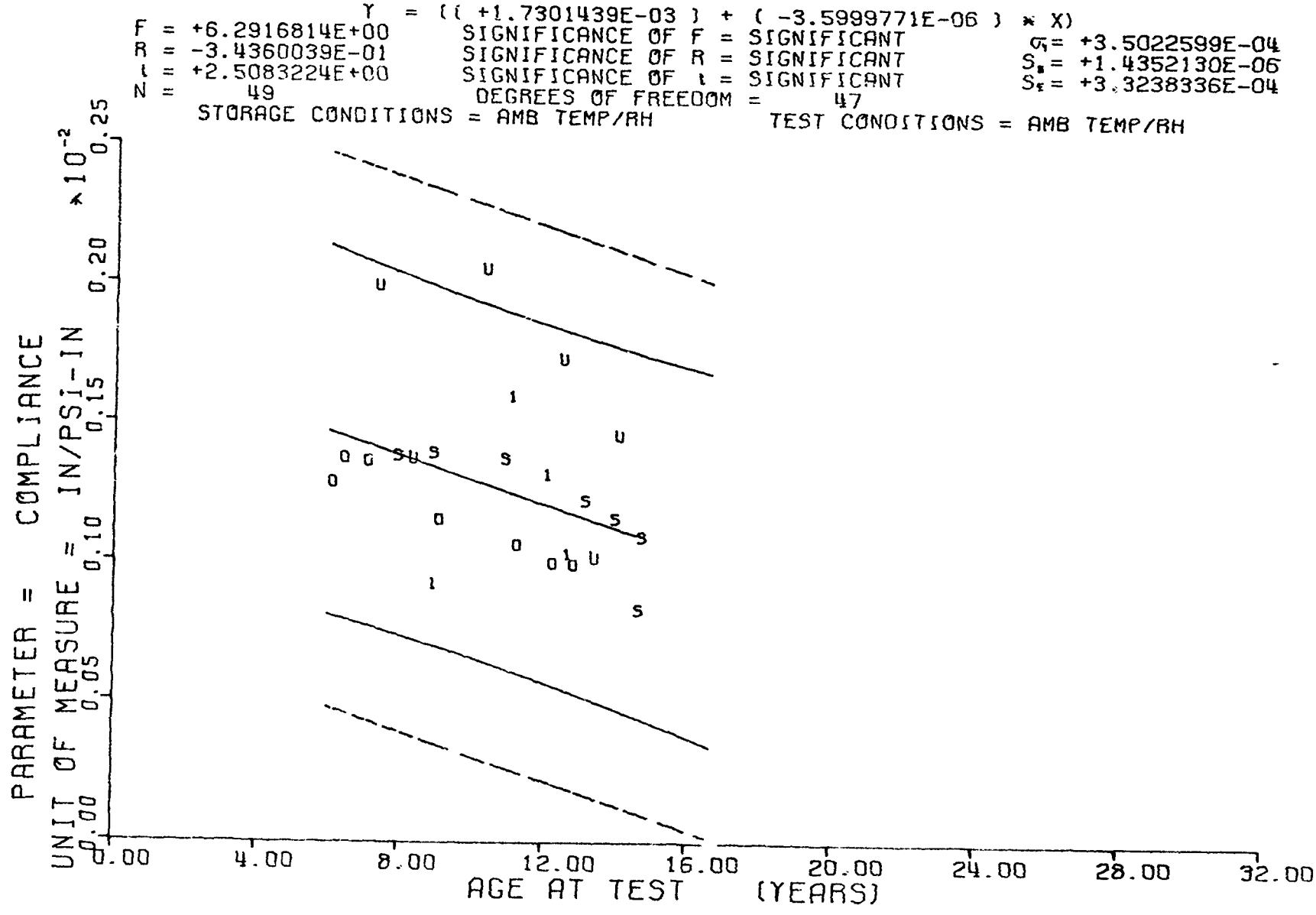
DISSECTED MOTOR TP-H1011.CREEP 10 LB LOAD.COMPLIANCE AT 10 SEC.

This sample size summary is applicable to figures 22 thru 24



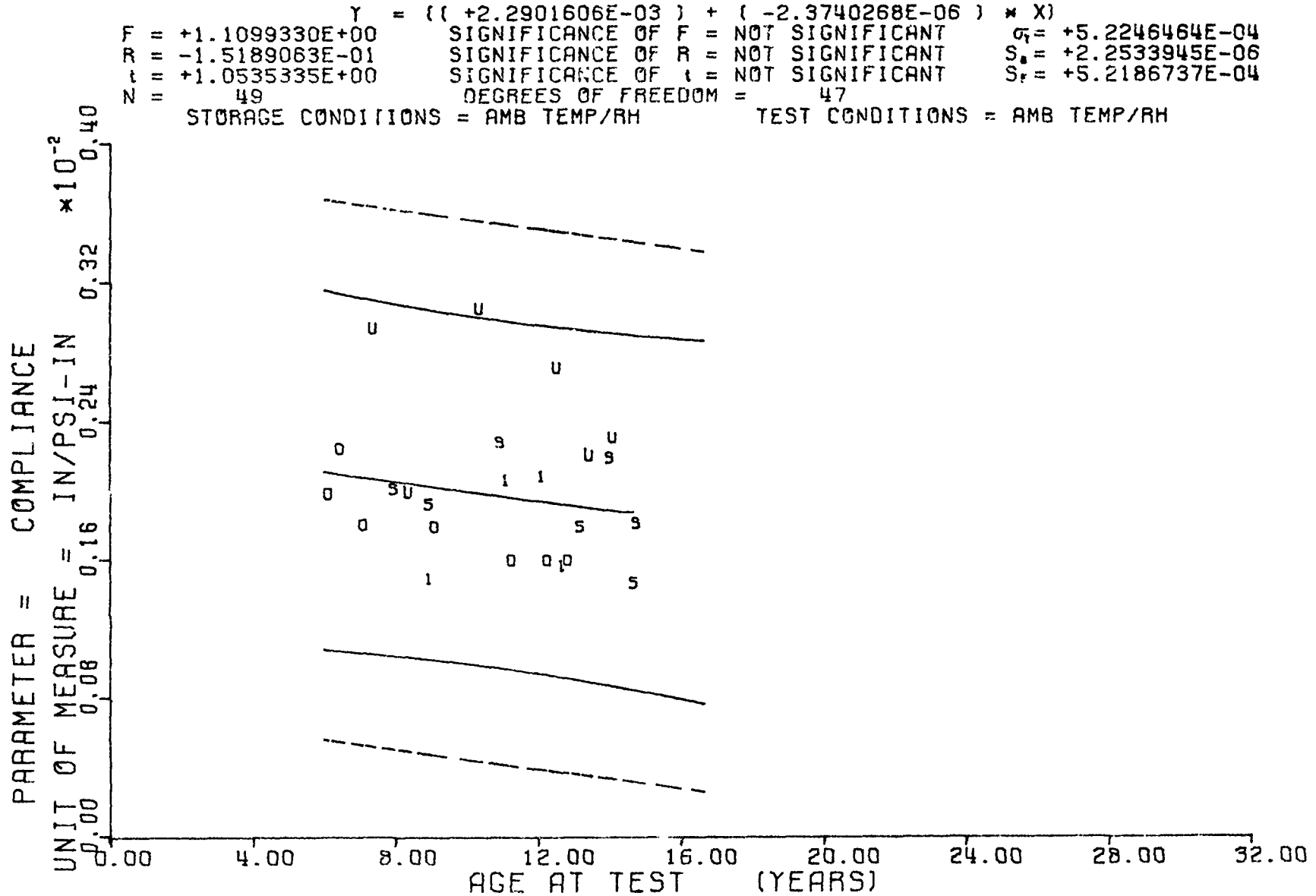
DISSECTED MOTOR TP-H1011,CREEP 10 LB LOAD,COMPLIANCE AT 10 SEC.

Figure 22



DISSECTED MOTOR TP-H1011, CREEP 10 LB LOAD, COMPLIANCE AT 20 SEC.

Figure 23



DISSECTED MOTOR TP-H1011, CREEP 10 LB LOAD, COMPLIANCE AT 1000 SEC.

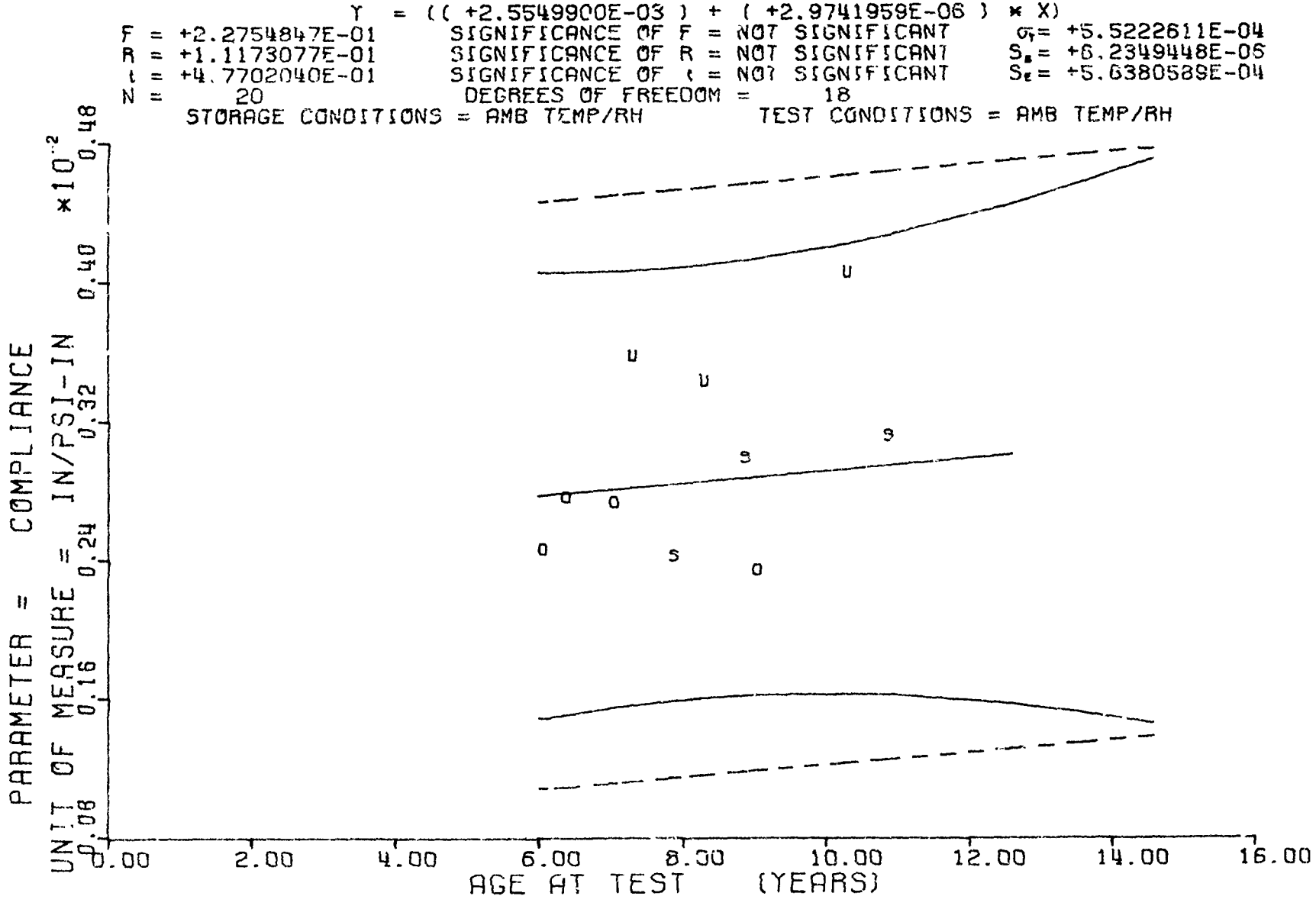
Figure 24

*** SAMPLE SIZE SUMMARY ***

AGE (MONTHS)	NR SAMPLES
72.0	2
76.0	3
84.0	2
87.0	2
94.0	2
99.0	2
106.0	3
108.0	1
123.0	1
130.0	1
151.0	1

DISSECTED NOTCH TP-H1011,CREEP 10 LB LOAD,COMPLIANCE AT 10.000 SEC.

This sample size summary is applicable to figure 25



DISSECTED MOTOR TP-H1011,CREEP 10 LB LOAD,COMPLIANCE AT 10,000 SEC.

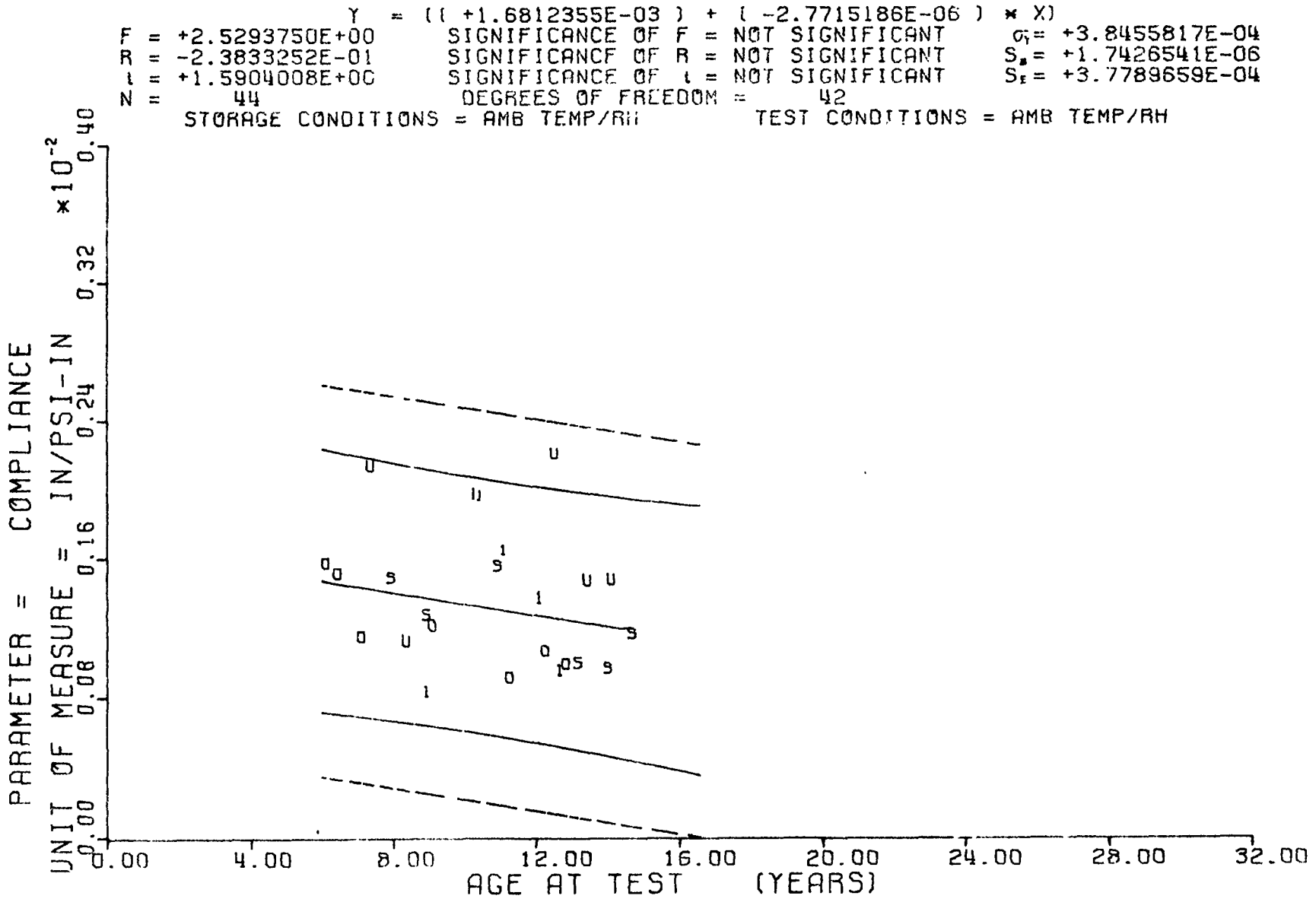
Figure 25

*** SAMPLE SIZE SUMMARY ***

AGE (MONTHS)	NR SAMPLES
72.0	2
76.0	3
84.0	2
87.0	2
94.0	2
99.0	2
106.0	3
108.0	1
123.0	1
130.0	1
132.0	2
134.0	2
144.0	2
146.0	2
149.0	2
151.0	2
153.0	3
157.0	2
160.0	2
167.0	1
168.0	3
175.0	2

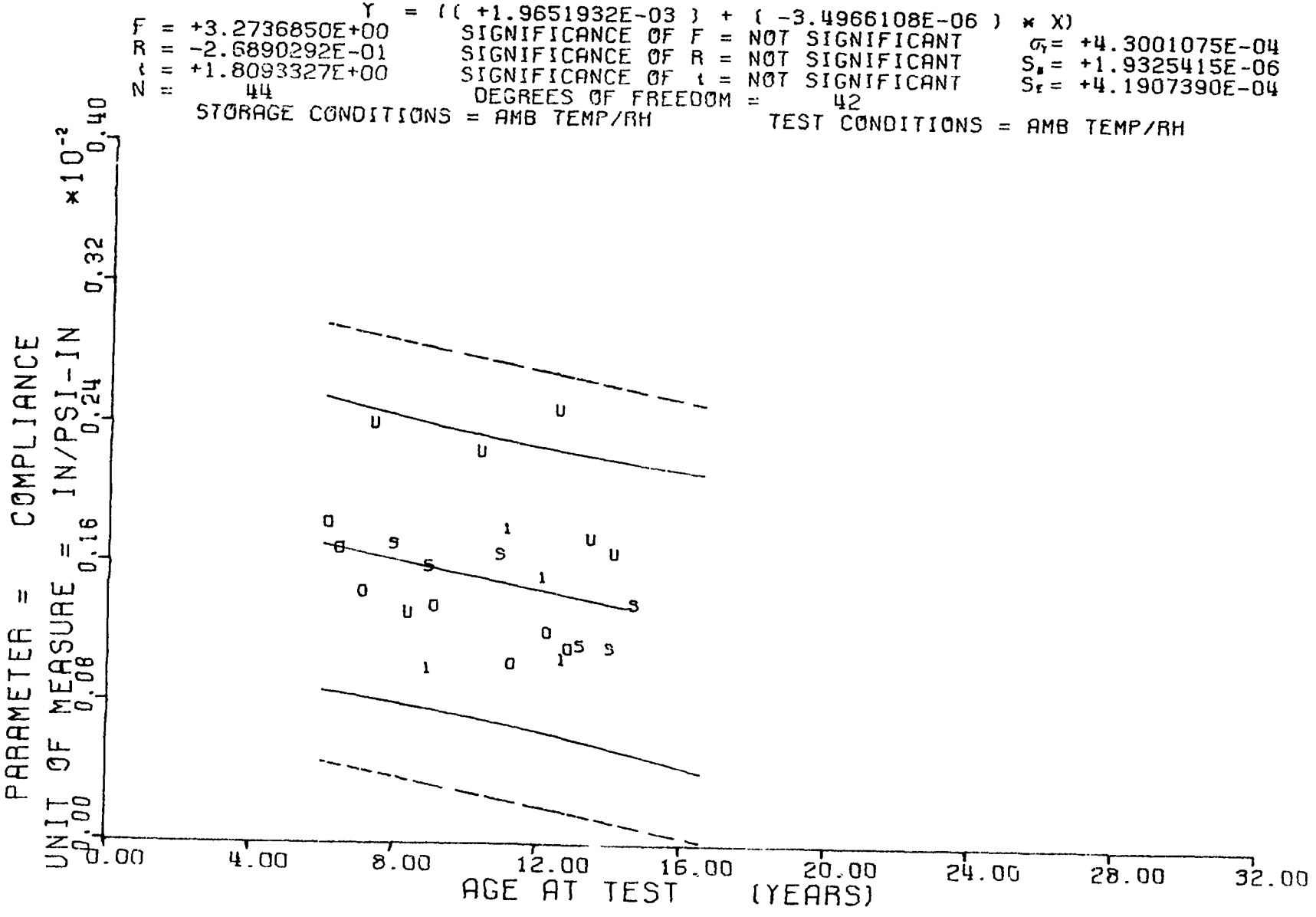
DISSECTED MOTOR TP-H1011,CREEP 12 LB LOAD,COMPLIANCE AT 10 SEC.

This sample size summary is applicable to figures 26 thru 28



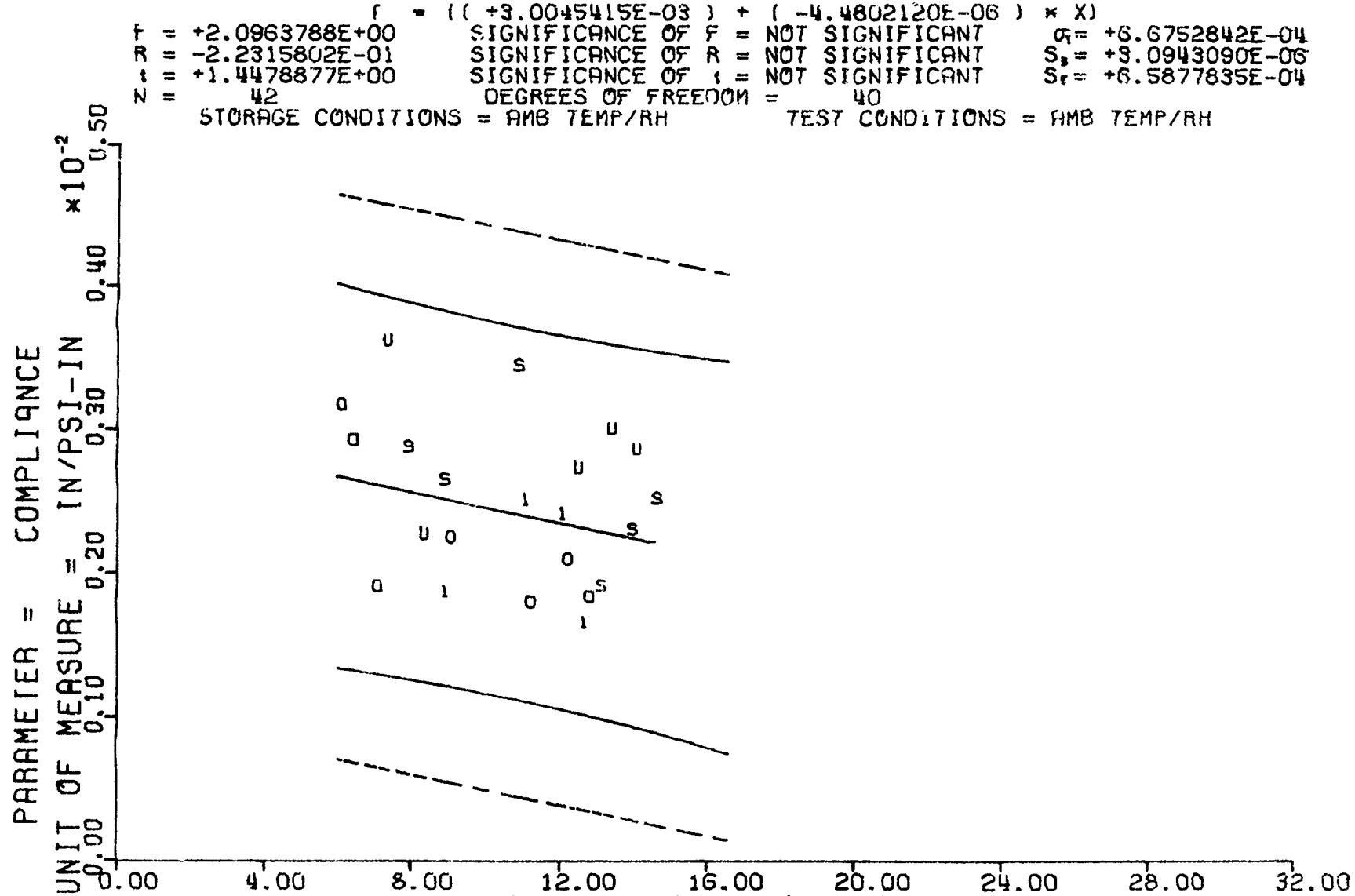
DISSECTED MOTOR TP-H1011, CREEP 12 LB LOAD, COMPLIANCE AT 10 SEC.

Figure 26



DISSECTED MOTOR TP-H1011, CREEP 12 LB LOAD, COMPLIANCE AT 20 SEC.

Figure 27



DISSECTED MOTOR TP-H1011, CREEP 12 LB LOAD, COMPLIANCE AT 1000 SEC.

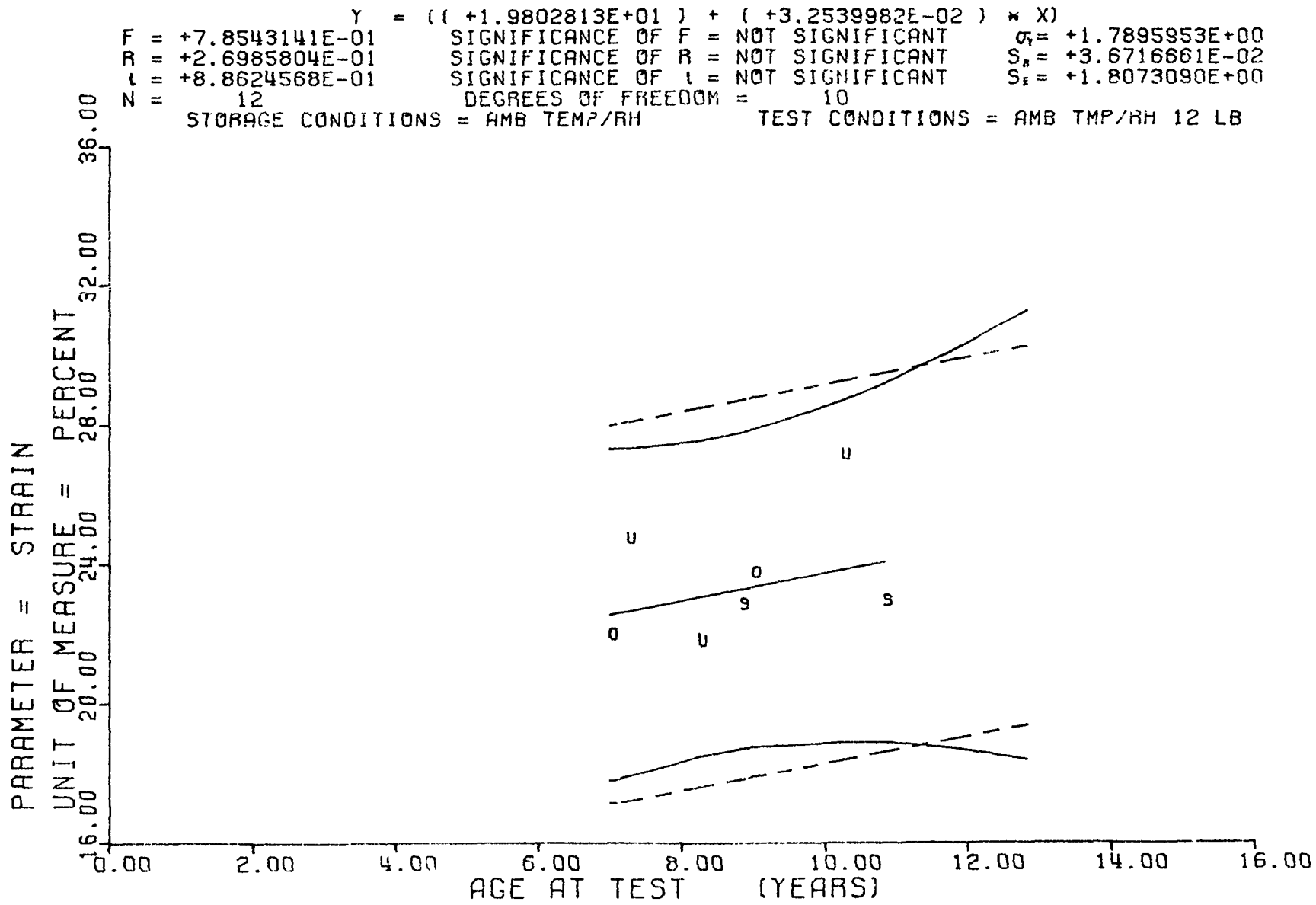
Figure 28

*** SAMPLE SIZE SUMMARY ***

AGE (MONTHS)	NR SAMPLES
84.0	2
87.0	2
99.0	2
106.0	3
108.0	1
123.0	1
130.0	1

TP-H1011 DISSECTED MOTORS, CREEP, % STRAIN AT RUPTURE, 12 LB LOAD

This sample size summary is applicable to figure 29



TP-H1011 DISSECTED MOTORS, CREEP, % STRAIN AT RUPTURE, 12 LB LOAD

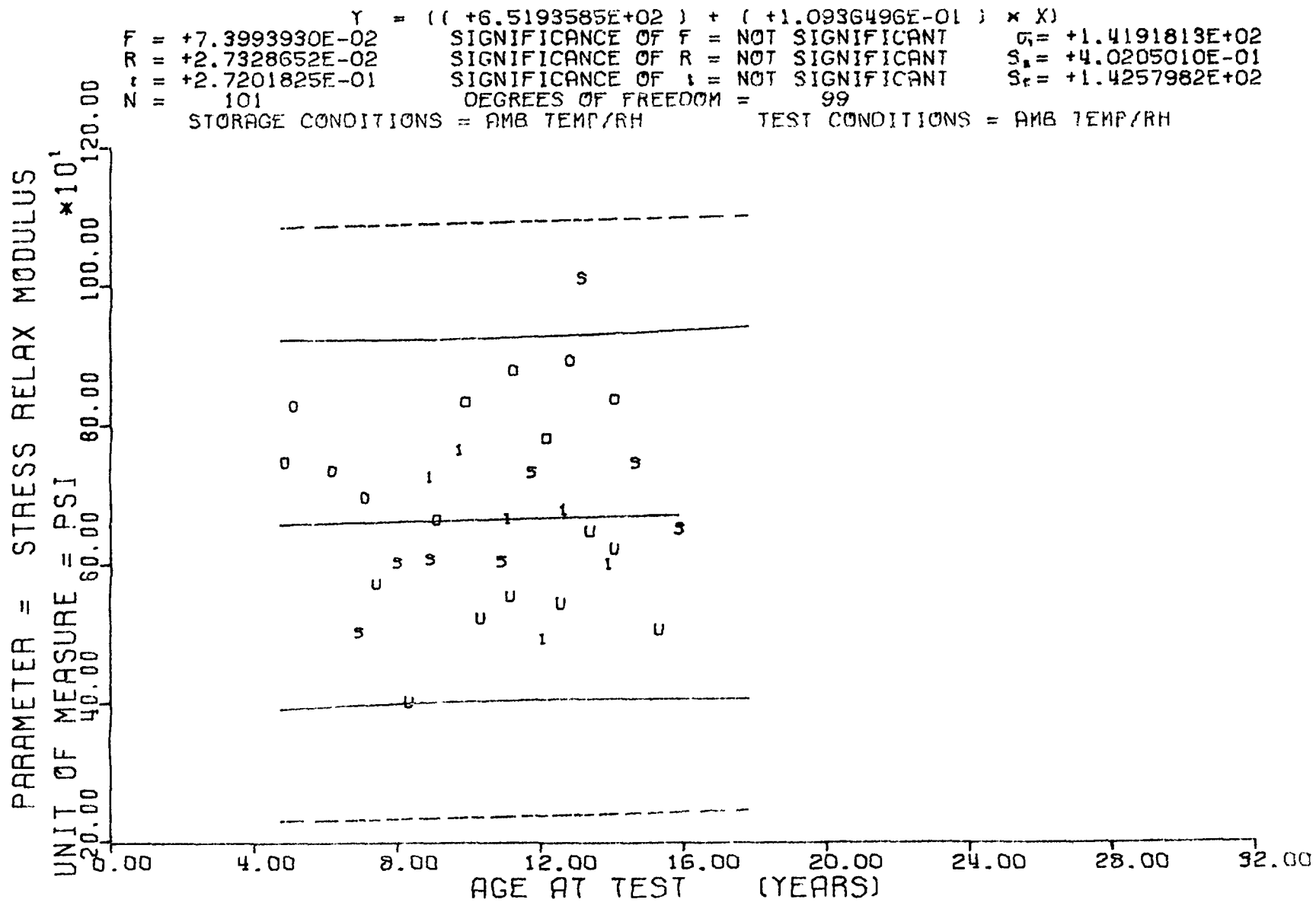
Figure 29

*** SAMPLE SIZE SUMMARY ***

AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES
57.0	3	166.0	3
60.0	3	168.0	9
73.0	3	175.0	3
82.0	3	183.0	3
84.0	3	190.0	3
88.0	3		
95.0	4		
99.0	3		
106.0	6		
108.0	3		
116.0	3		
118.0	3		
123.0	3		
130.0	3		
132.0	3		
133.0	3		
134.0	3		
140.0	3		
144.0	4		
145.0	3		
150.0	3		
151.0	3		
153.0	3		
157.0	3		
160.0	3		

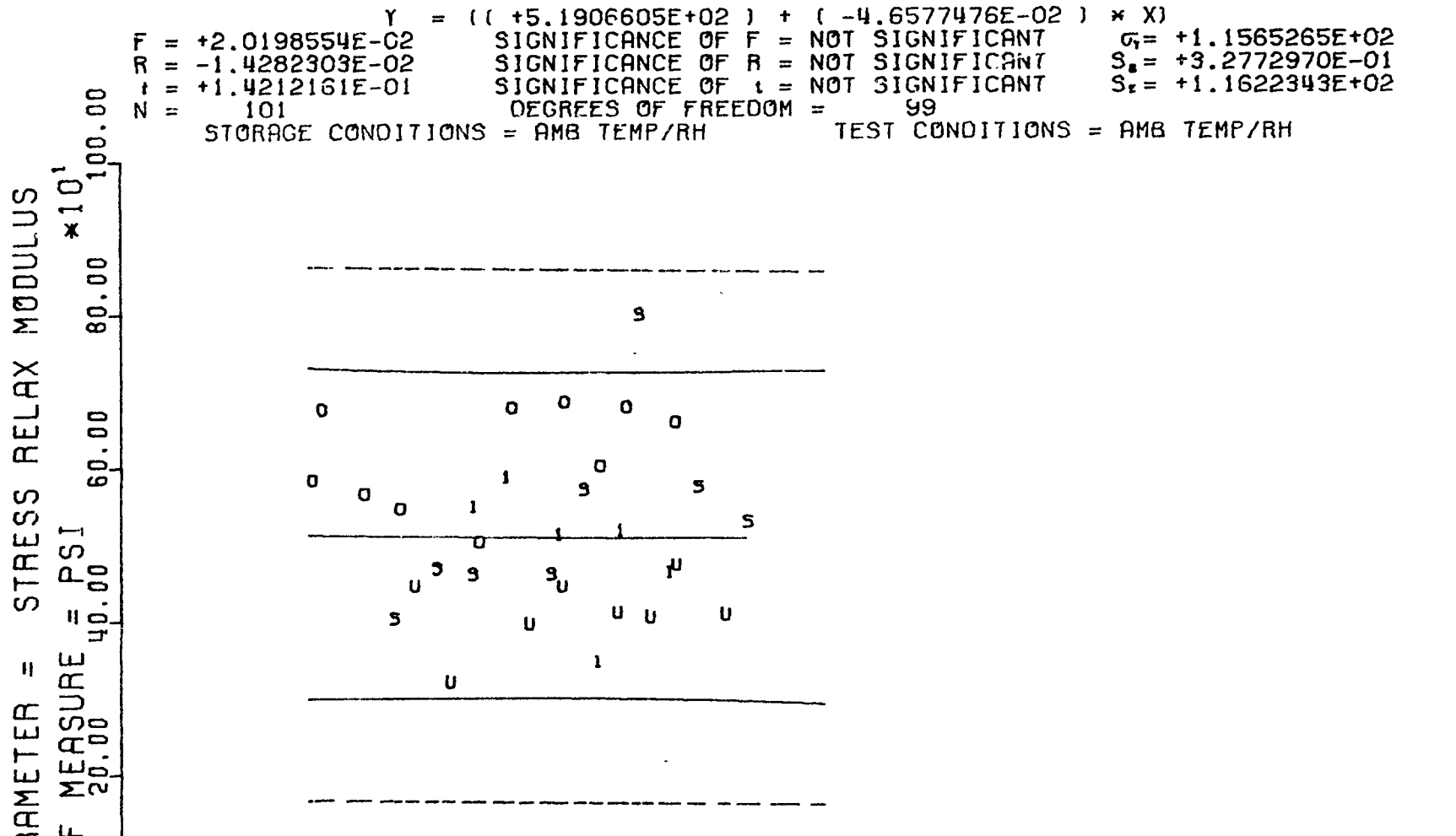
TP-H1011 DISSECTED MTRS, STRESS RELAXATION MODULUS, 3 PERCENT STRAIN, 10 SEC

This sample size summary is applicable to figures 30 thru 33



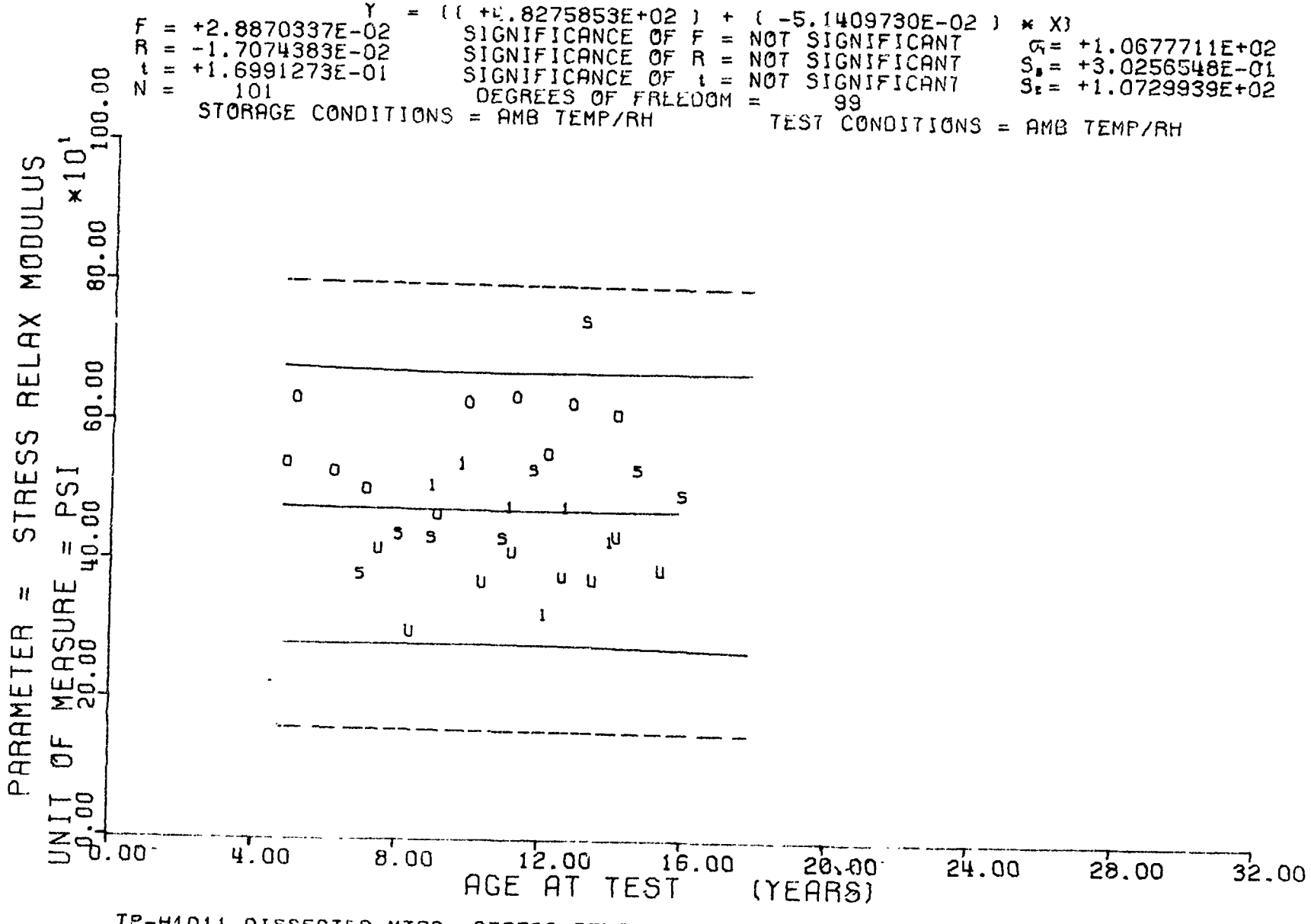
TP-H1011 DISSECTED MTRS, STRESS RELAXATION MODULUS, 5 PERCENT STRAIN, 10 SEC

Figure 30



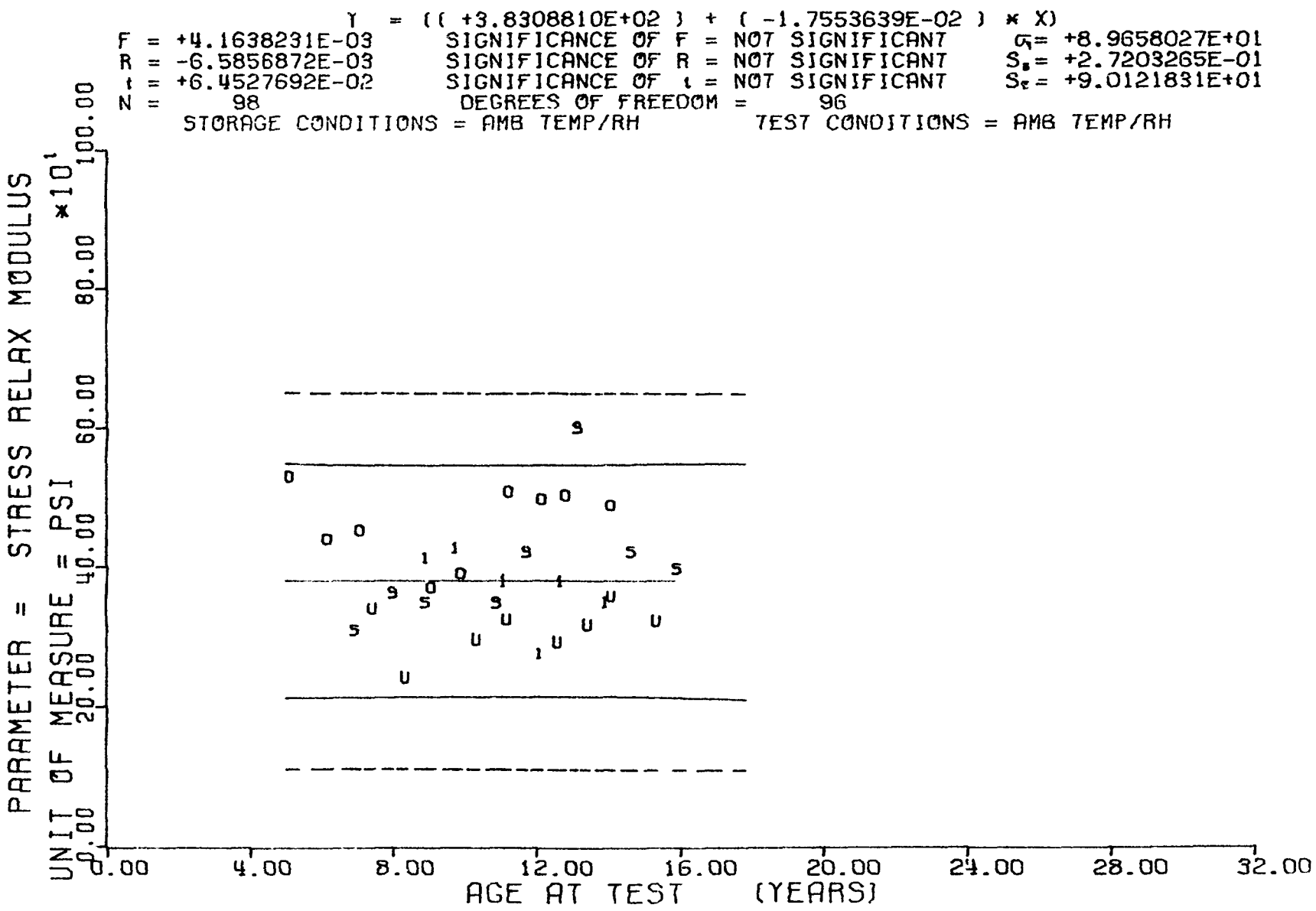
TP-H1011 DISSECTED MTRS, STRESS RELAXATION MODULUS, 3 PERCENT STRAIN, 50 SEC

Figure 31



TP-H1011 DISSECTED MTRS, STRESS RELAXATION MODULUS, 3 PERCENT STRAIN, 100 SEC

Figure 32



TP-H1011 DISSECTED MTRS, STRESS RELAXATION MODULUS, 3 PERCENT STRAIN, 1000 SEC

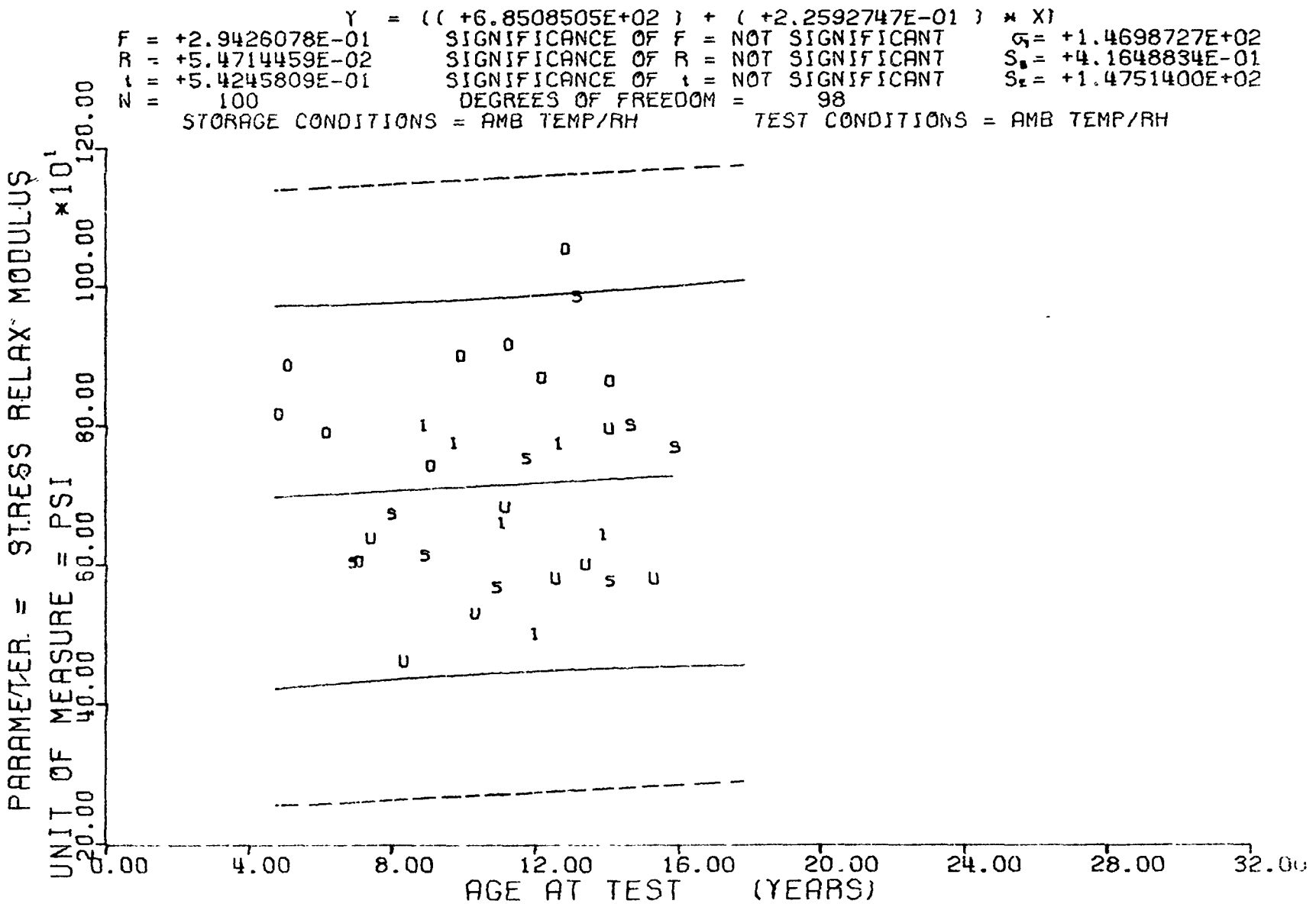
Figure 33

*** SAMPLE SIZE SUMMARY ***

AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES
57.0	3	166.0	3
60.0	3	168.0	9
73.0	3	175.0	3
82.0	3	183.0	3
84.0	3	190.0	3
88.0	3		
95.0	4		
99.0	3		
106.0	6		
108.0	3		
116.0	3		
118.0	3		
123.0	3		
130.0	3		
132.0	3		
133.0	3		
134.0	3		
140.0	3		
143.0	3		
145.0	3		
150.0	3		
151.0	3		
153.0	3		
157.0	3		
160.0	3		

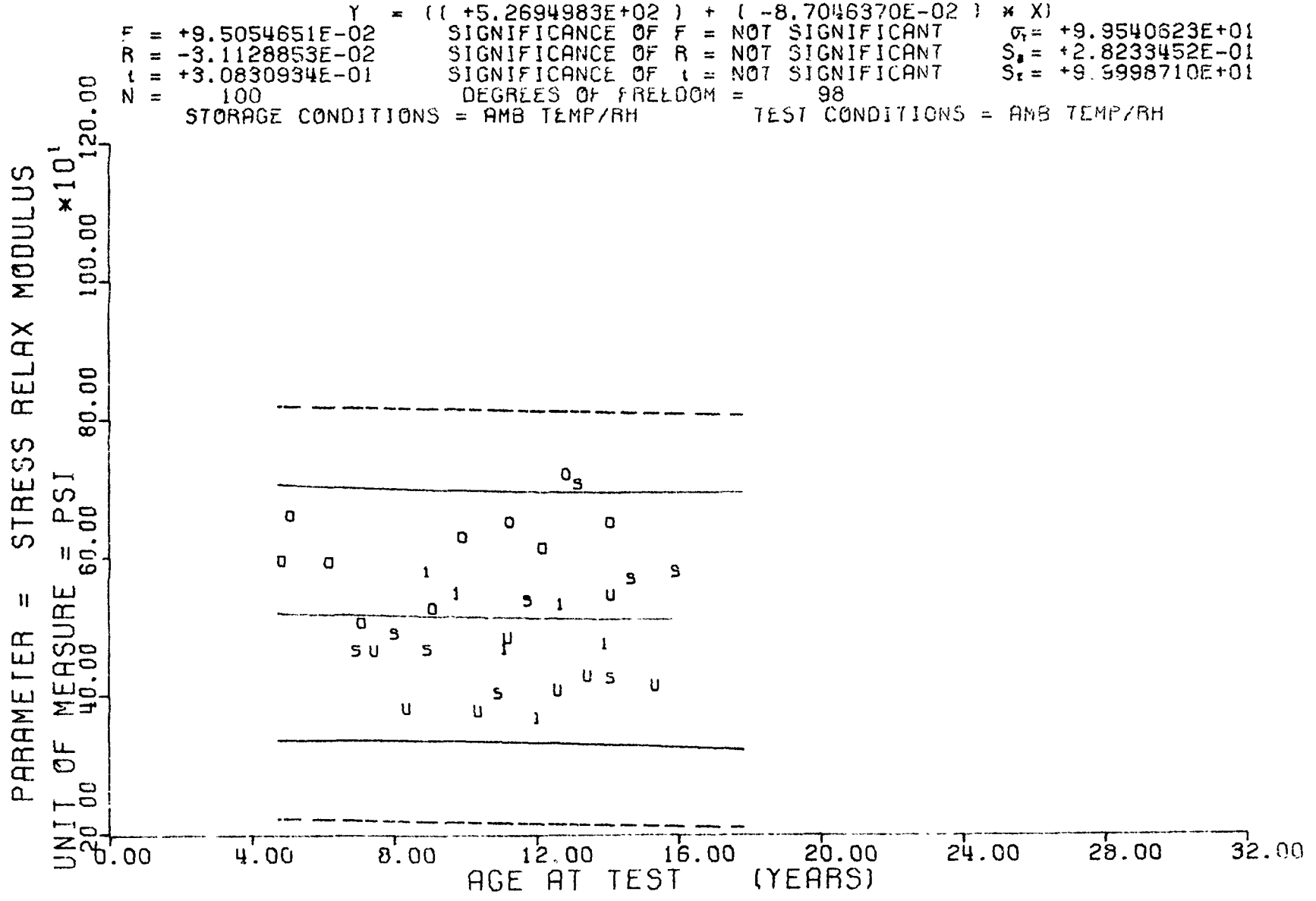
TP-H1011 DISSECTED MTRS, STRESS RELAXATION MODULUS, 5 PERCENT STRAIN, 10 SEC

This sample size summary is applidable to figures 34 thru 37



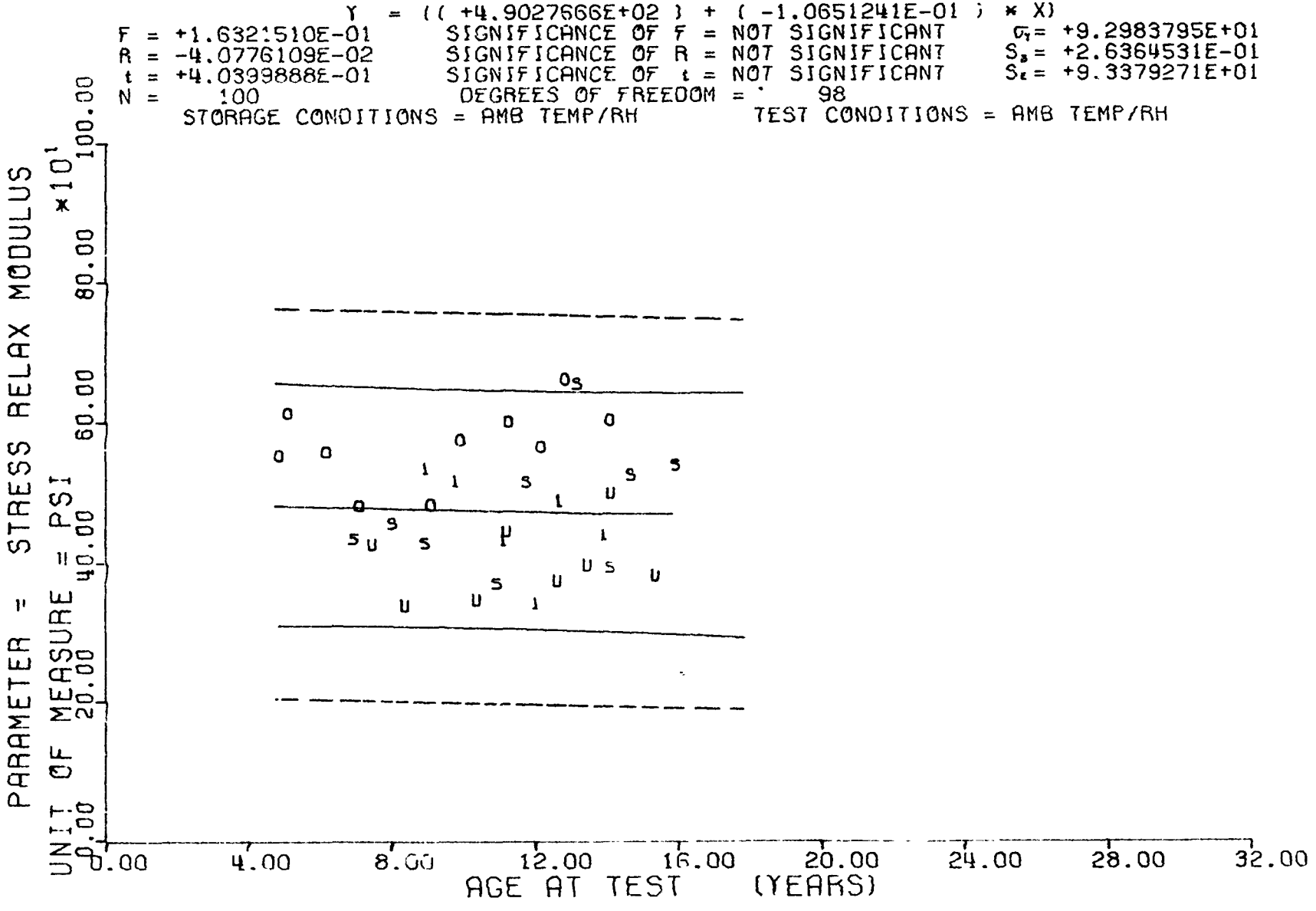
TP-H1011 DISSECTED MTRS, STRESS RELAXATION MODULUS, 5 PERCENT STRAIN, 10 SEC

Figure 34



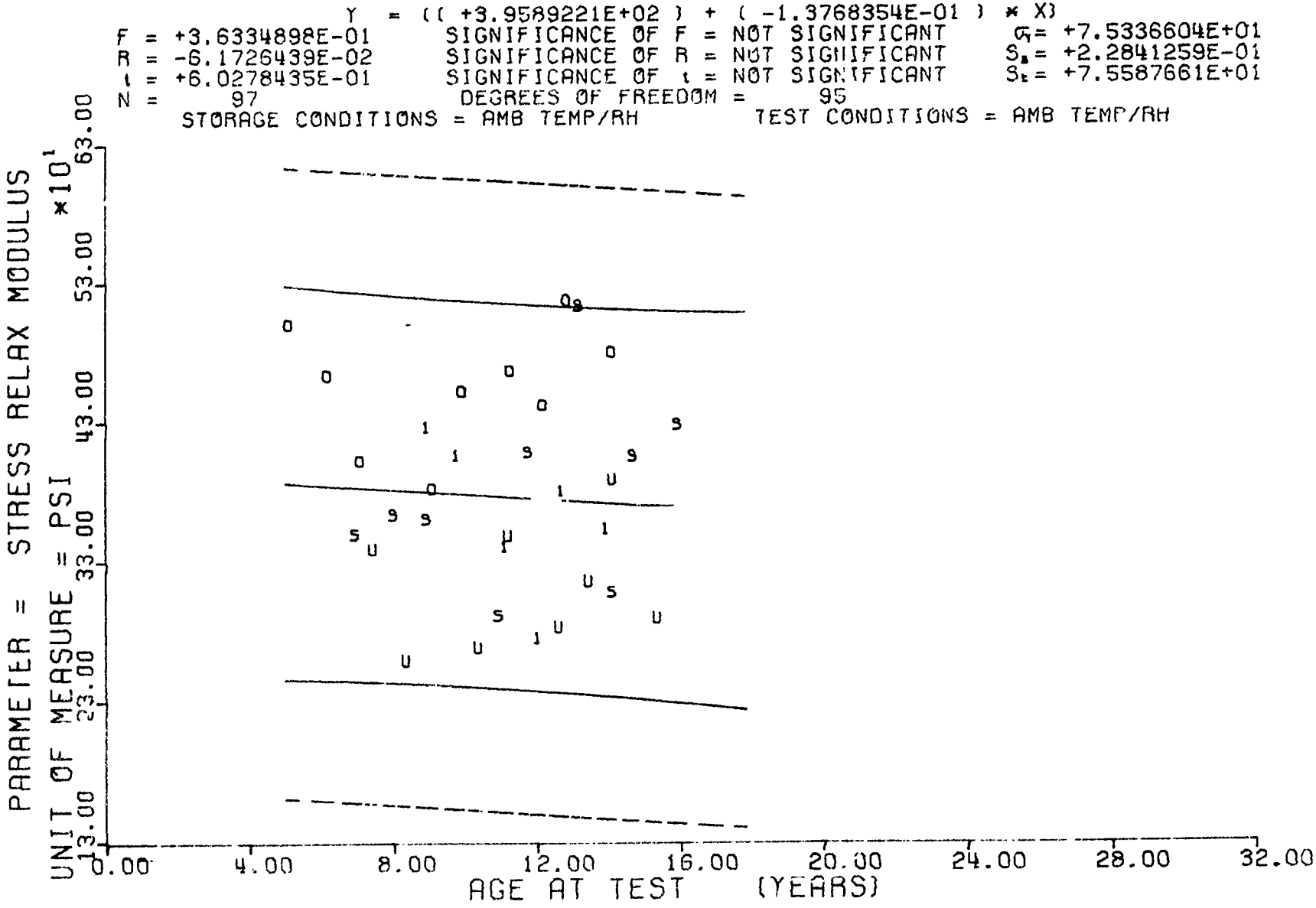
TP-H1011 DISSECTED MTRS, STRESS RELAXATION MODULUS, 5 PERCENT STRAIN, 50 SEC

Figure 35



TP-H1011 DISSECTED MTRS, STRESS RELAXATION MODULUS, 5 PERCENT STRAIN, 100 SEC

Figure 36



TR-H1011 DISSECTED MTRS, STRESS RELAXATION MODULUS, 5 PERCENT STRAIN, 1000 SEC

Figure 37

*** SAMPLE SIZE SUMM RY ***

AGE (MONTHS)	NR SAMPLES
72.0	16
83.0	1
94.0	1
105.0	1
107.0	1
109.0	1
117.0	1
120.0	1
131.0	1
135.0	2
137.0	2
142.0	1
159.0	2

STAGE 1 DSSCTD MTRS, CONSTANT STRAIN, STRAIN 0.1 INIT AND 0.01 EVERY 48 HRS

This sample size summary is applicable to figure 38

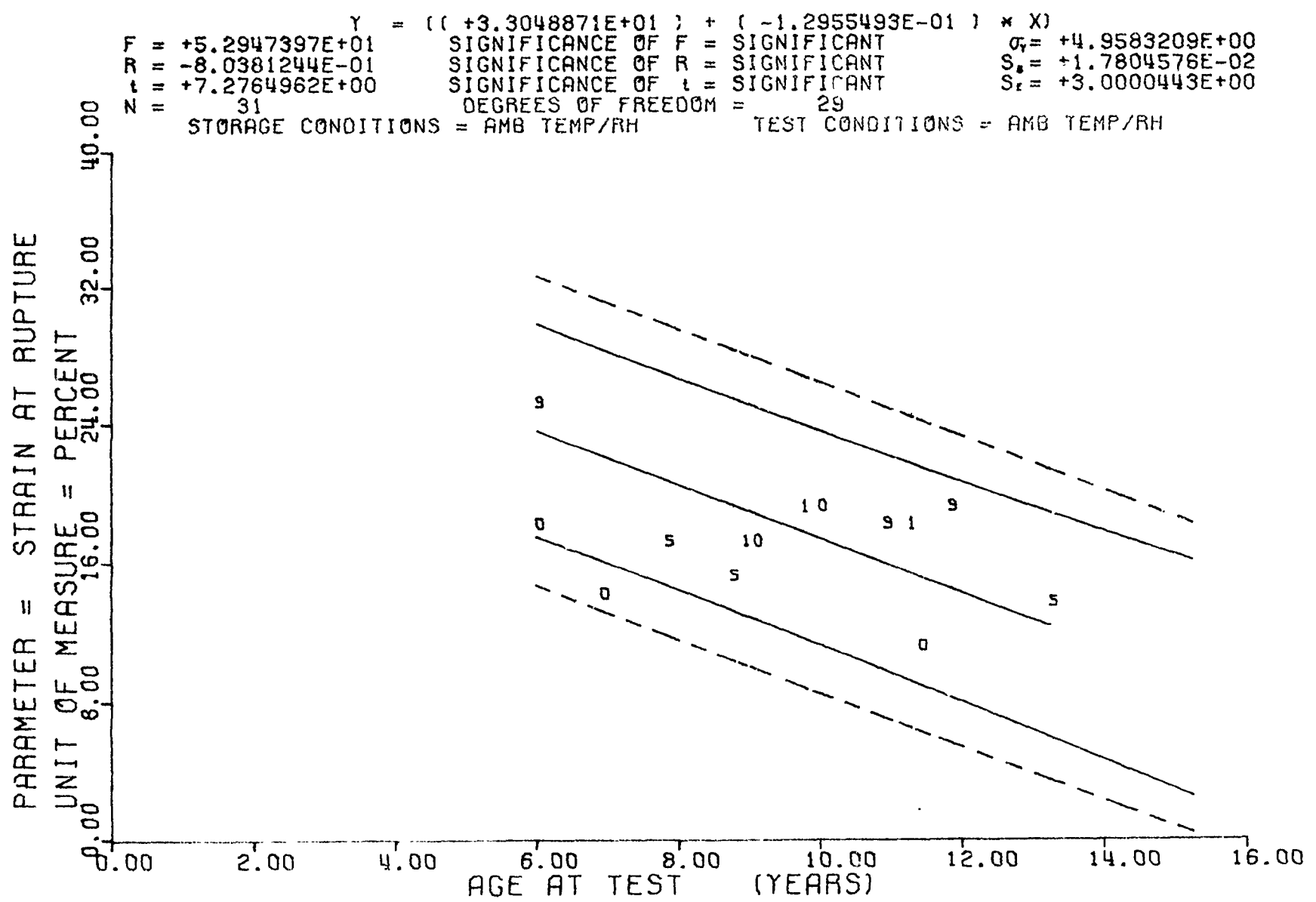

Y = ((+3.3048871E+01) + (-1.2955493E-01) * X)
F = +5.2947397E+01 SIGNIFICANCE OF F = SIGNIFICANT
R = -8.0381244E-01 SIGNIFICANCE OF R = SIGNIFICANT
t = +7.2764962E+00 SIGNIFICANCE OF t = SIGNIFICANT
N = 31 DEGREES OF FREEDOM = 29
STORAGE CONDITIONS = AMB TEMP/RH
TEST CONDITIONS = AMB TEMP/RH
PARAMETER = STRAIN AT RUPTURE
UNIT OF MEASURE = PERCENT
0.00
8.00
16.00
24.00
32.00
40.00
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
AGE AT TEST (YEARS)
STAGE 1 DSSCTO MTRS, CONSTANT STRAIN, STRAIN 0.1 INIT AND 0.01 EVERY 48 HRS

Figure 38

*** SAMPLE SIZE SUMMARY ***

AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES
71.0	6	183.0	10
82.0	5	189.0	10
86.0	6		
93.0	1		
97.0	5		
104.0	5		
105.0	5		
107.0	5		
115.0	5		
117.0	5		
122.0	5		
130.0	5		
132.0	10		
134.0	5		
140.0	5		
143.0	3		
145.0	3		
149.0	5		
150.0	5		
152.0	5		
156.0	5		
160.0	3		
167.0	3		
168.0	20		
175.0	5		

STAGE 1 DISSECTED MTRS, SHORE A HARDNESS, 10 SECOND

This sample size summary is applicable to figure 39

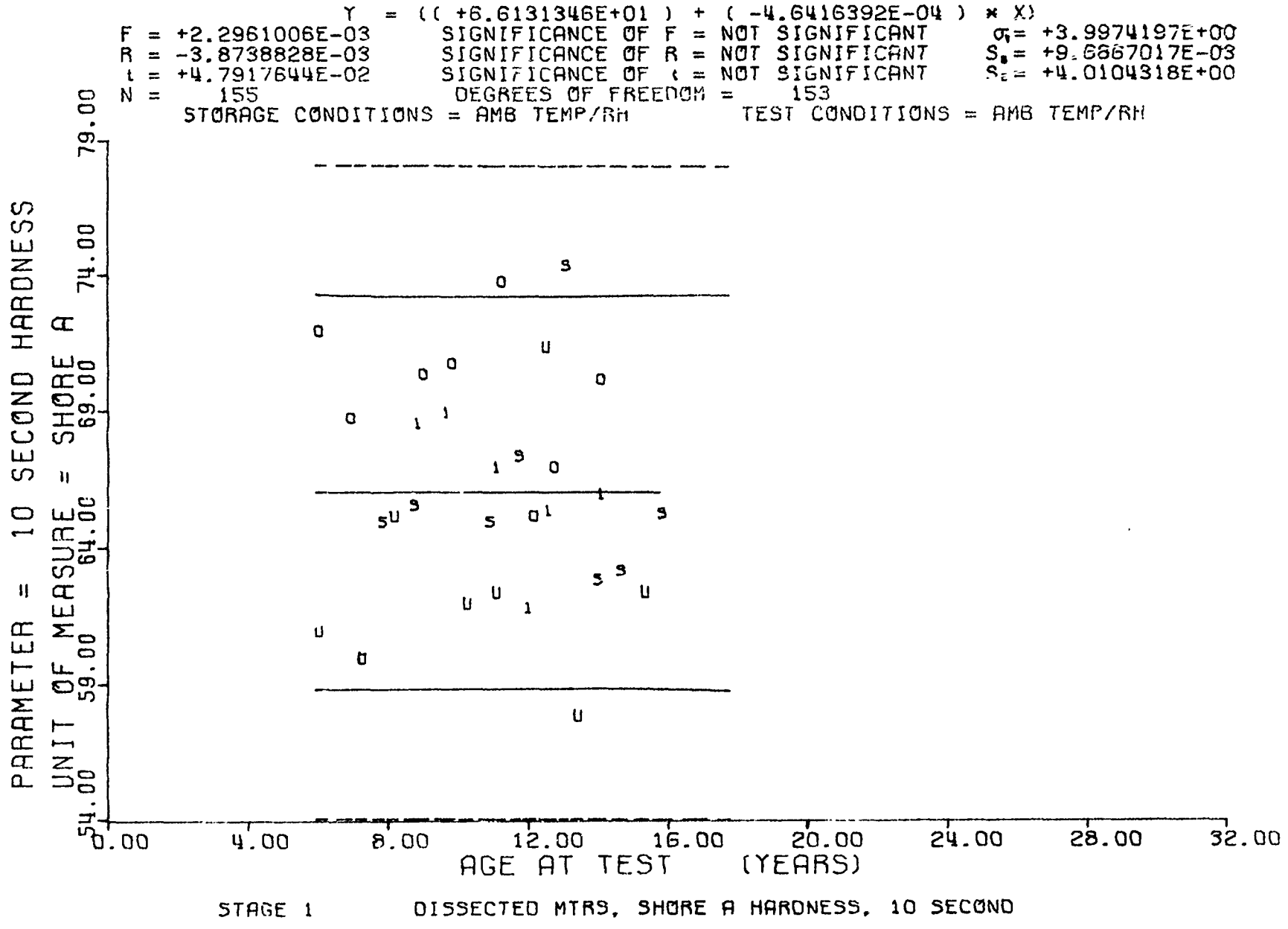

Y = ((+6.6131346E+01) + (-4.6416392E-04) * X)
F = +2.2961006E-03 SIGNIFICANCE OF F = NOT SIGNIFICANT σ = +3.9974197E+00
R = -3.8738828E-03 SIGNIFICANCE OF R = NOT SIGNIFICANT S = +9.6667017E-03
t = +4.7917644E-02 SIGNIFICANCE OF t = NOT SIGNIFICANT S = +4.0104318E+00
N = 155 DEGREES OF FREEDOM = 153
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = 10 SECOND HARDNESS
UNIT OF MEASURE = SHORE A
79.00
74.00
69.00
64.00
59.00
54.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1 DISSECTED MTRS, SHORE A HARDNESS, 10 SECOND

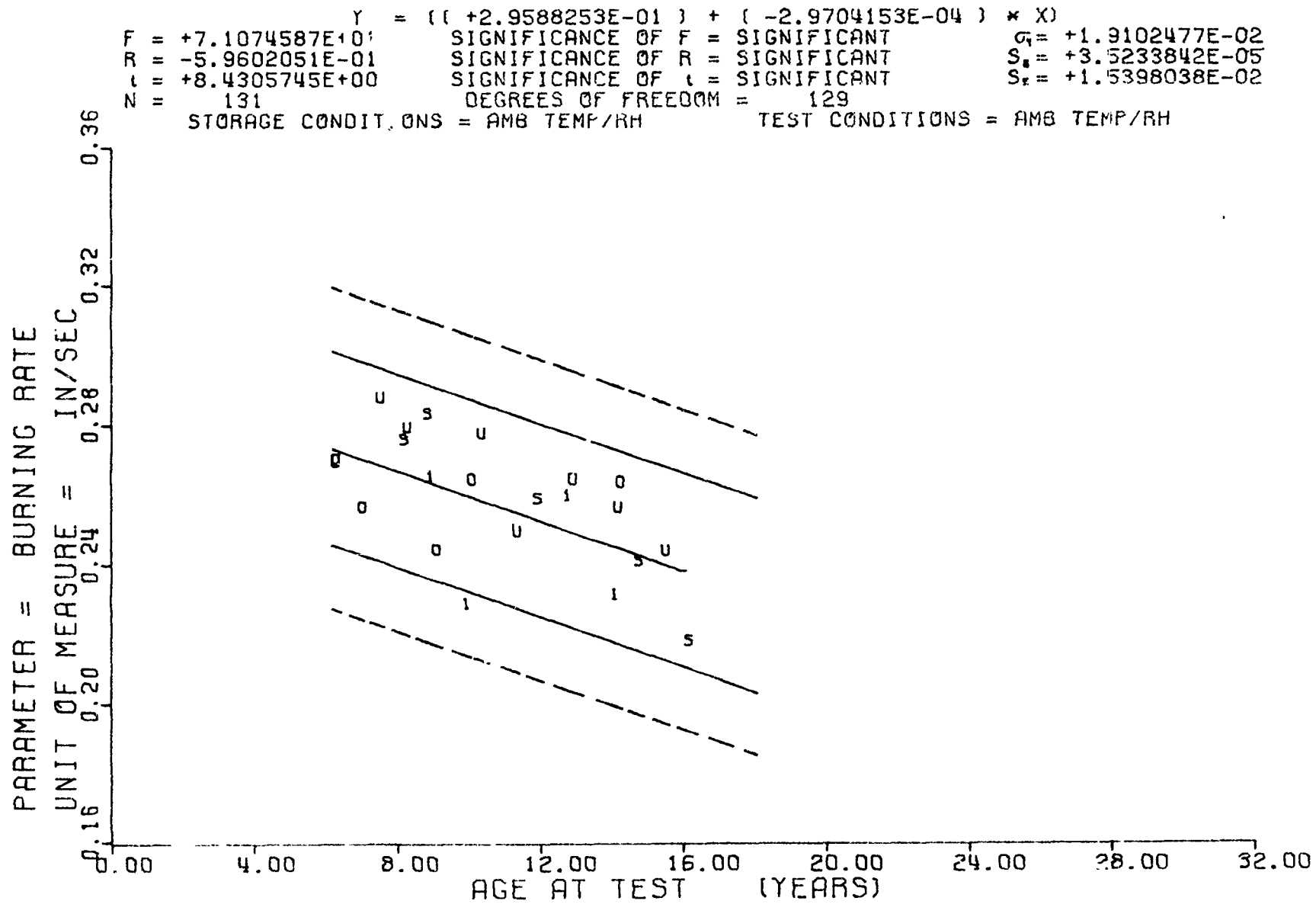
Figure 39

*** SA· .E SIZE SUMMARY ***

AGE (MONTHS)	NR SAMPLES
74.0	18
83.0	6
89.0	5
97.0	6
98.0	6
105.0	6
106.0	5
108.0	5
118.0	5
120.0	5
123.0	5
135.0	5
142.0	5
152.0	6
154.0	6
168.0	6
169.0	6
170.0	6
176.0	6
185.0	6
193.0	6

STAGE 1 DISSECTED MOTORS, BURNING RATE AT 500 PSI INITIAL PRESSURE

This sample size summary is applicable to figure 40



STAGE 1 DISSECTED MOTORS, BURNING RATE AT 500 PSI INITIAL PRESSURE

Figure 40

*** SAMPLE SIZE SUMMARY ***

AGE (MONTHS)	NR SAMPLES	AGE (MONTHS)	NR SAMPLES
74.0	6	176.0	6
83.0	6	185.0	6
89.0	6	193.0	6
97.0	6		
98.0	6		
105.0	6		
106.0	5		
108.0	5		
118.0	5		
120.0	5		
123.0	5		
130.0	10		
135.0	5		
137.0	8		
139.0	5		
142.0	5		
145.0	6		
147.0	5		
152.0	5		
154.0	11		
161.0	5		
162.0	5		
168.0	6		
169.0	11		
170.0	6		

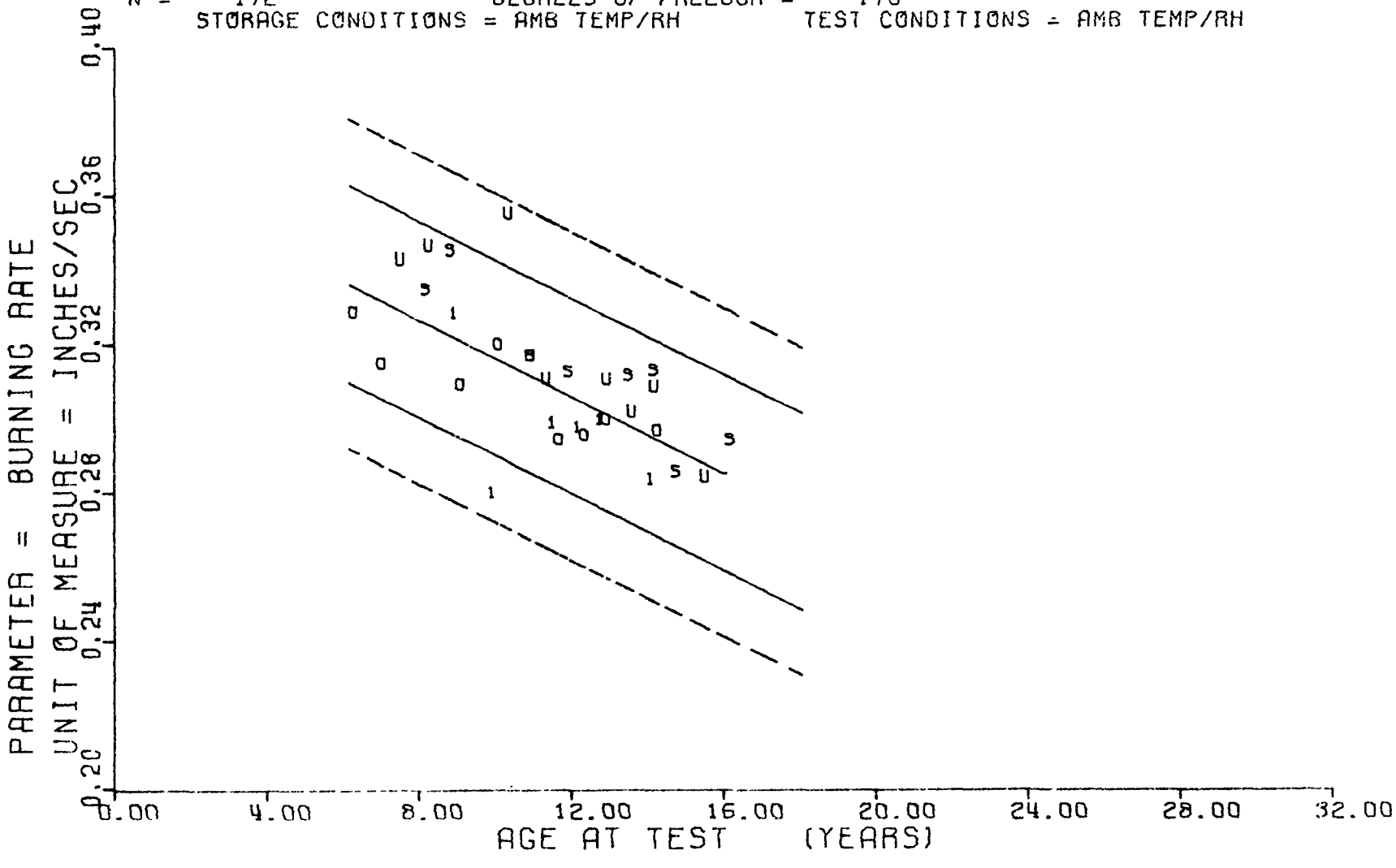
STAGE 1 DISSECTED MOTORS, BURNING RATE AT 1000 PSI INITIAL PRESSURE

This sample size summary is applicable to figure 41

$Y = ((+3.6862352E-01) + (-4.3013127E-04) \times X_i$

F = +1.4356181E+02	SIGNIFICANCE OF F = SIGNIFICANT	σ_Y = +2.0067250E-02
R = -6.7664034E-01	SIGNIFICANCE OF R = SIGNIFICANT	S_a = +3.5898933E-05
t = +1.1981728E+01	SIGNIFICANCE OF t = SIGNIFICANT	S_E = +1.4819185E-02
N = 172	DEGREES OF FREEDOM = 170	

STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH



STAGE 1 DISSECTED MOTORS, BURNING RATE AT 1000 PSI INITIAL PRESSURE

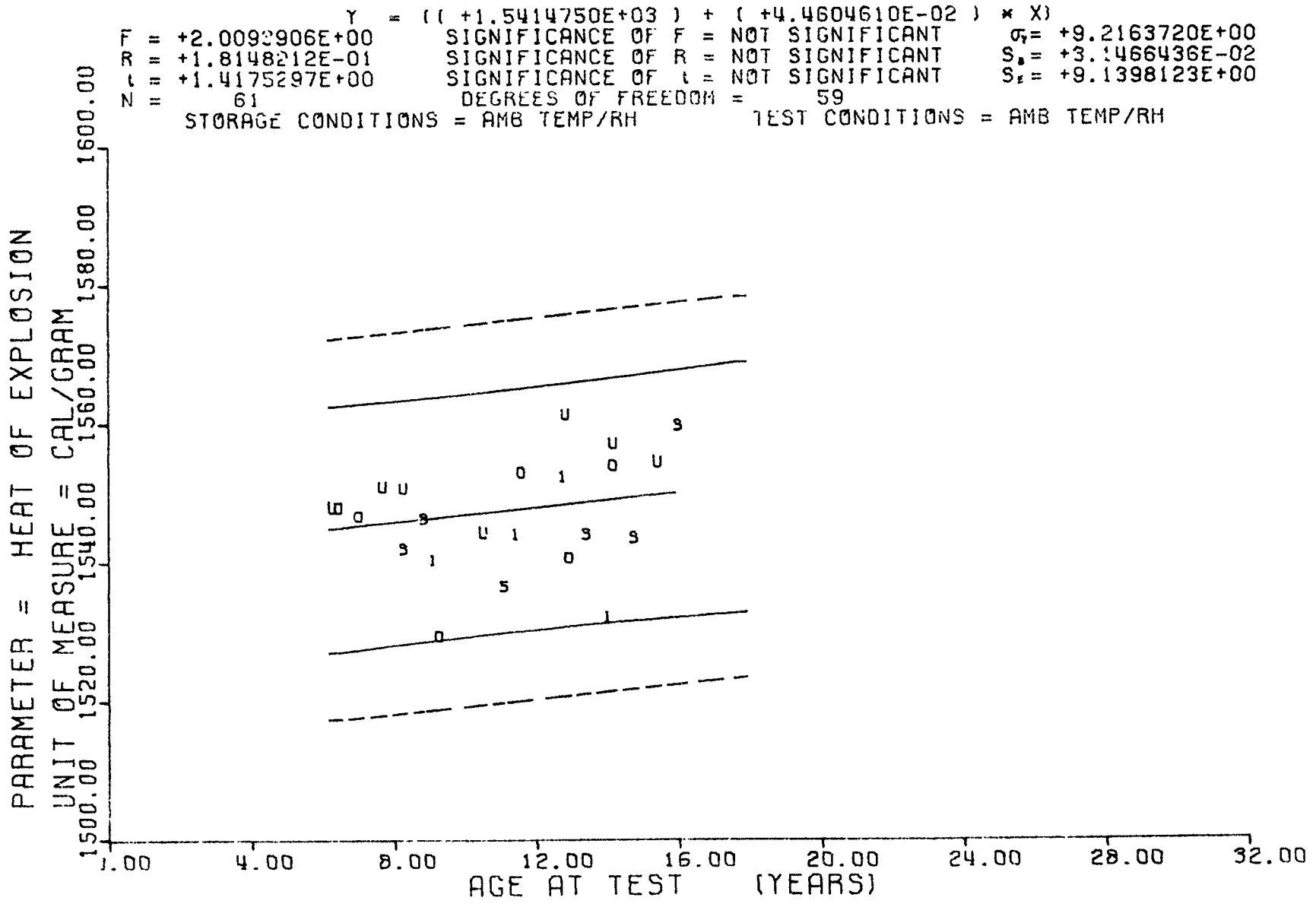
Figure 41

*** SAMPLE SIZE SUMMARY **

AGE (MONTHS)	NR SAMPLES
74.0	3
76.0	3
83.0	3
91.0	3
98.0	6
105.0	3
108.0	1
110.0	1
125.0	1
132.0	1
136.0	3
138.0	3
152.0	3
153.0	3
154.0	3
160.0	3
167.0	3
169.0	6
176.0	3
184.0	3
191.0	3

STAGE 1 DISSECTED MOTORS, HEAT OF EXPLOSION

This sample size summary is applicable to figure 42



STAGE 1 DISSECTED MOTORS, HEAT OF EXPLOSION

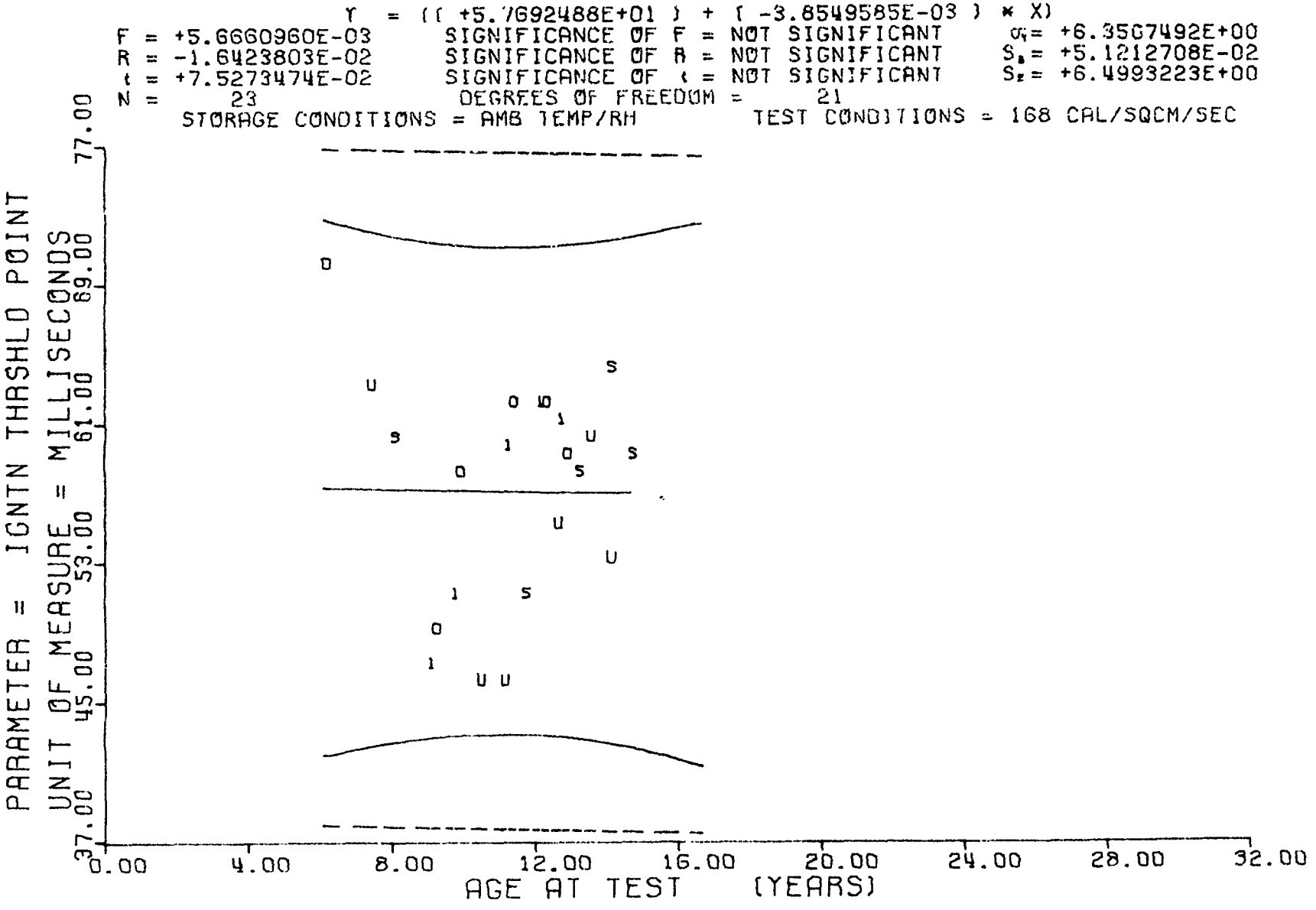
Figure 42

*** SAMPLE SIZE SUMMARY ***

AGE (MONTHS)	NR SAMPLES
73.0	1
88.0	1
96.0	1
108.0	1
110.0	1
116.0	1
118.0	1
125.0	1
133.0	1
134.0	2
136.0	1
140.0	1
145.0	1
147.0	1
151.0	1
152.0	1
154.0	1
158.0	1
162.0	1
169.0	2
176.0	1

STAGE 1 DISSECTED MTRS, IGNITABILITY, IGNTN THRSHLD POINT 168 (CAL/SQCM)/SEC

This sample size summary is applicable to figure 43



STAGE 1 DISSECTED MTRS, IGNITABILITY, IGNTN THRSHLD POINT 168 (CAL/SQCM)/SEC

Figure 43

*** SAMPLE SIZE SUMMARY ***

AGE (MONTHS)	NR SAMPLES
73.0	4
75.0	3
83.0	2
90.0	3
98.0	9
105.0	5
114.0	3
118.0	3
133.0	3
135.0	3
137.0	3
140.0	3
152.0	2
154.0	3
160.0	3
167.0	3
169.0	9
176.0	3
184.0	5
192.0	3

STAGE 1 DISSECTED MOTORS, DTA, ENDOTHERM 1, 12 DEGREE C RISE/MINUTE

This sample size summary is applicable to figures 44 and 45

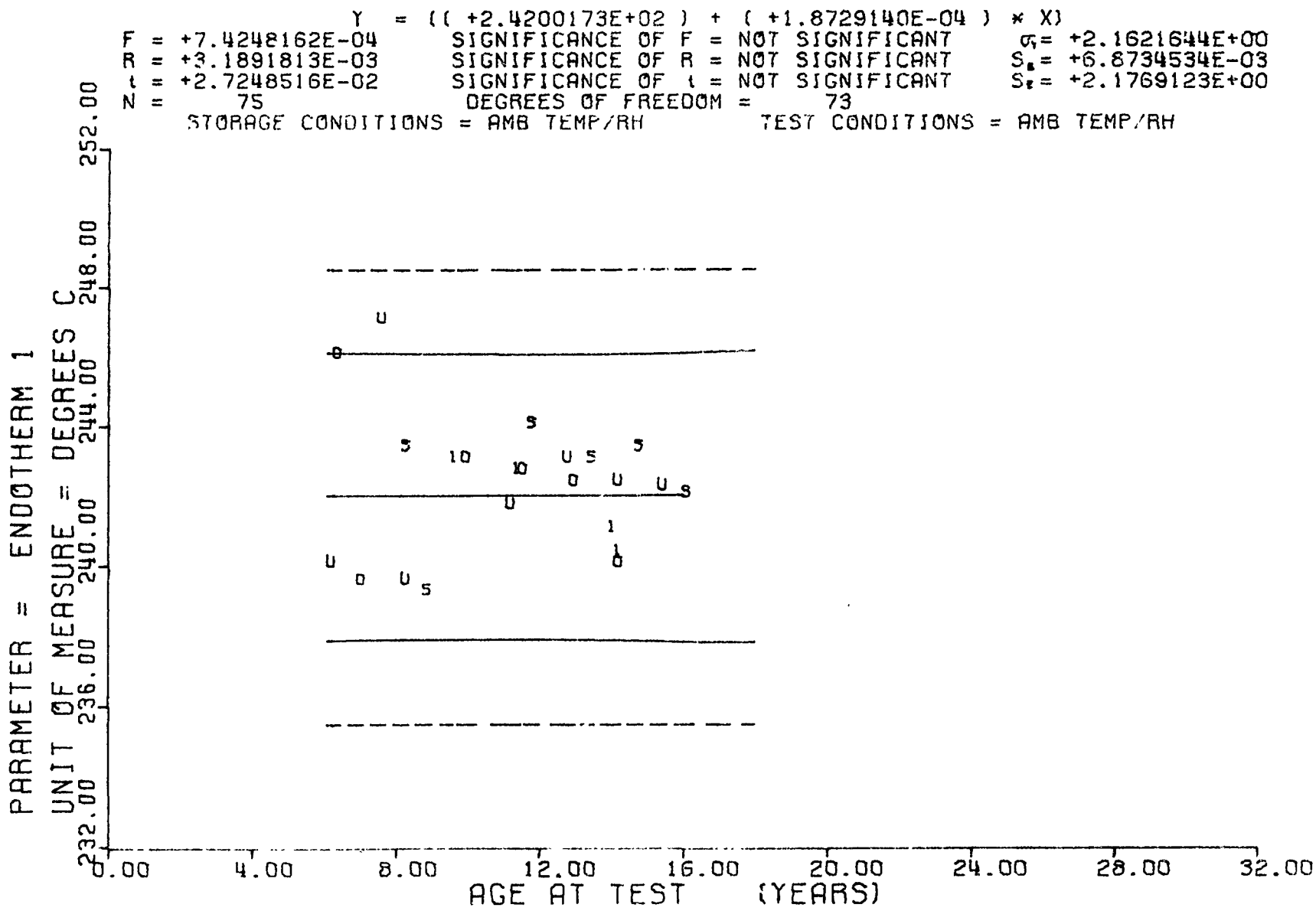

Y = ((+2.4200173E+02) + (+1.8729140E-04) * X)
F = +7.4248162E-04 SIGNIFICANCE OF F = NOT SIGNIFICANT σr = +2.1621644E+00
R = +3.1891813E-03 SIGNIFICANCE OF R = NOT SIGNIFICANT Sb = +6.8734534E-03
t = +2.7248516E-02 SIGNIFICANCE OF t = NOT SIGNIFICANT St = +2.1769123E+00
N = 75 DEGREES OF FREEDOM = 73
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = ENDOTHERM 1
UNIT OF MEASURE = DEGREES C
252.00
248.00
244.00
240.00
236.00
232.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1 DISSECTED MOTORS, DTA, ENDOTHERM 1, 12 DEGREE C RISE/MINUTE

Figure 44

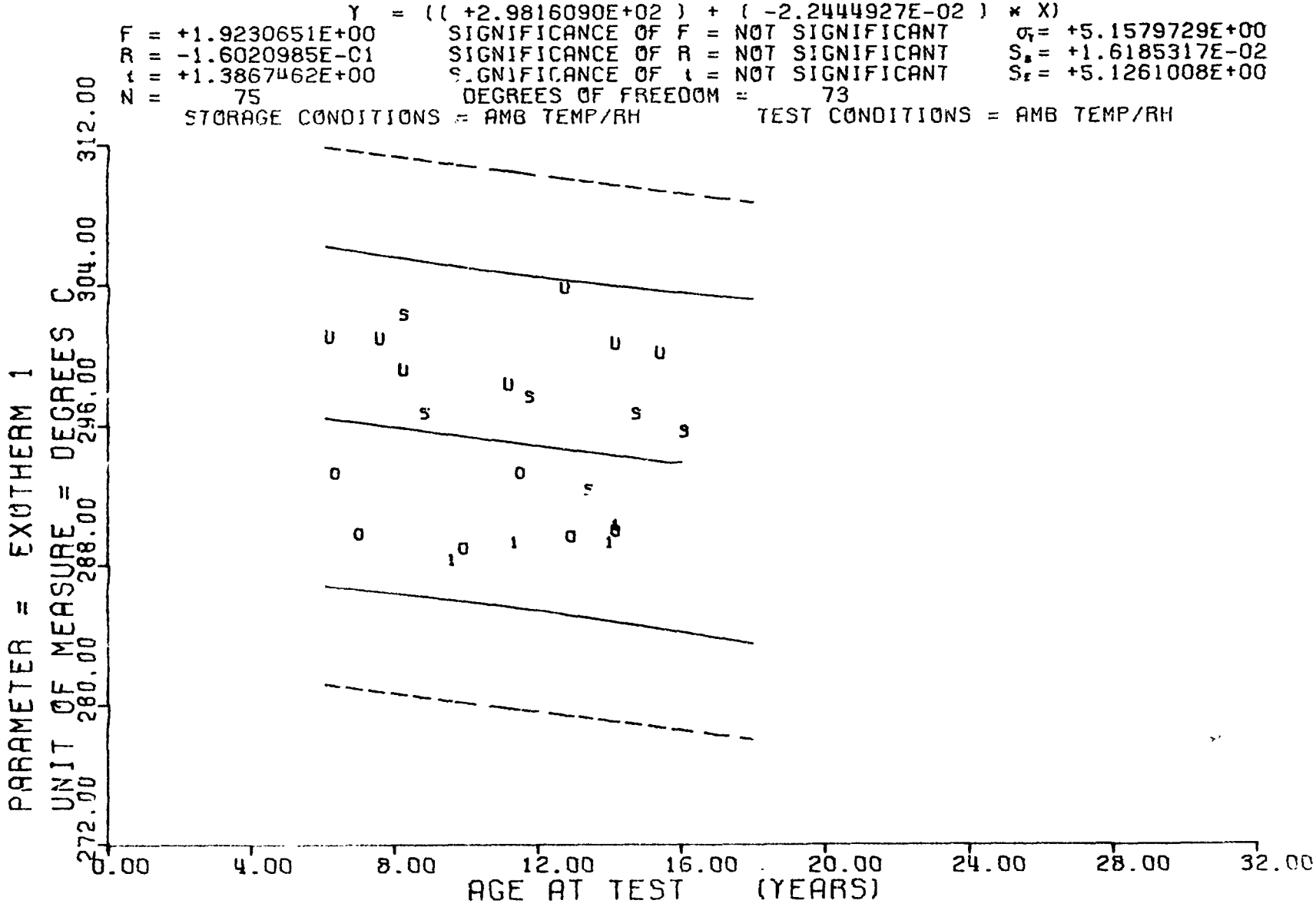

Y = ((+2.9816090E+02) + (-2.2444927E-02) * X)
F = +1.9230651E+00 SIGNIFICANCE OF F = NOT SIGNIFICANT σ = +5.1579729E+00
R = -1.6020985E-01 SIGNIFICANCE OF R = NOT SIGNIFICANT S = +1.6185317E-02
t = +1.3867462E+00 SIGNIFICANCE OF t = NOT SIGNIFICANT S = +5.1261008E+00
N = 75 DEGREES OF FREEDOM = 73
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = EXOTHERM 1
UNIT OF MEASURE = DEGREES C
312.00
304.00
296.00
288.00
280.00
272.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
STAGE 1 DISSECTED MOTORS, DTA, EXOTHERM 1, 12 DEGREE C RISE/MINUTE

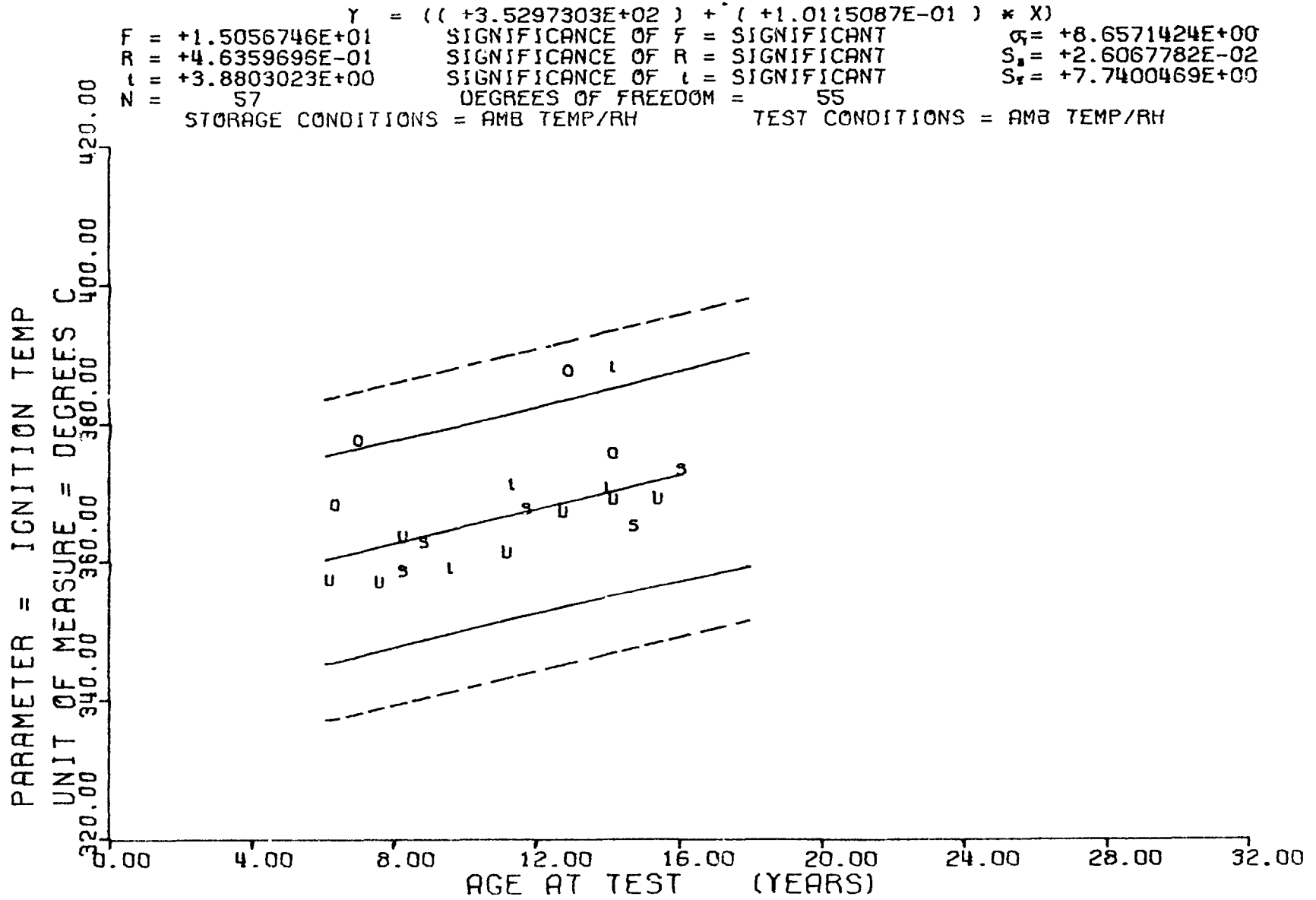
Figure 45

*** SAMPLE SIZE SUMMARY ***

AGE (MONTHS)	NR SAMPLES
73.0	4
75.0	3
83.0	2
90.0	3
98.0	9
105.0	5
114.0	2
133.0	3
135.0	2
140.0	3
152.0	2
154.0	1
167.0	2
169.0	6
176.0	2
184.0	5
192.0	3

STAGE 1 DISSECTED MOTORS, DTA IGNITION TEMP, 12 DEG C RISE/MINUTE

This sample size summary is applicable to figure 46



STAGE 1 DISSECTED MOTORS, DTA IGNITION TEMP, 12 DEG C RISE/MINUTE

Figure 46

*** SAMPLE SIZE SUMMARY ***

AGE (MONTHS)	NR SAMPLES
133.0	4
135.0	4
146.0	4
148.0	4
150.0	4
152.0	4
154.0	4
157.0	4
163.0	4
167.0	6
169.0	4
170.0	4
176.0	4
184.0	6
191.0	6

DISSECTED MTR, STAGE 1, TP-H1011, SOL GEL, PERCENT EXTRACTABLES

This sample size summary is applicable tc figures 47 thru 50

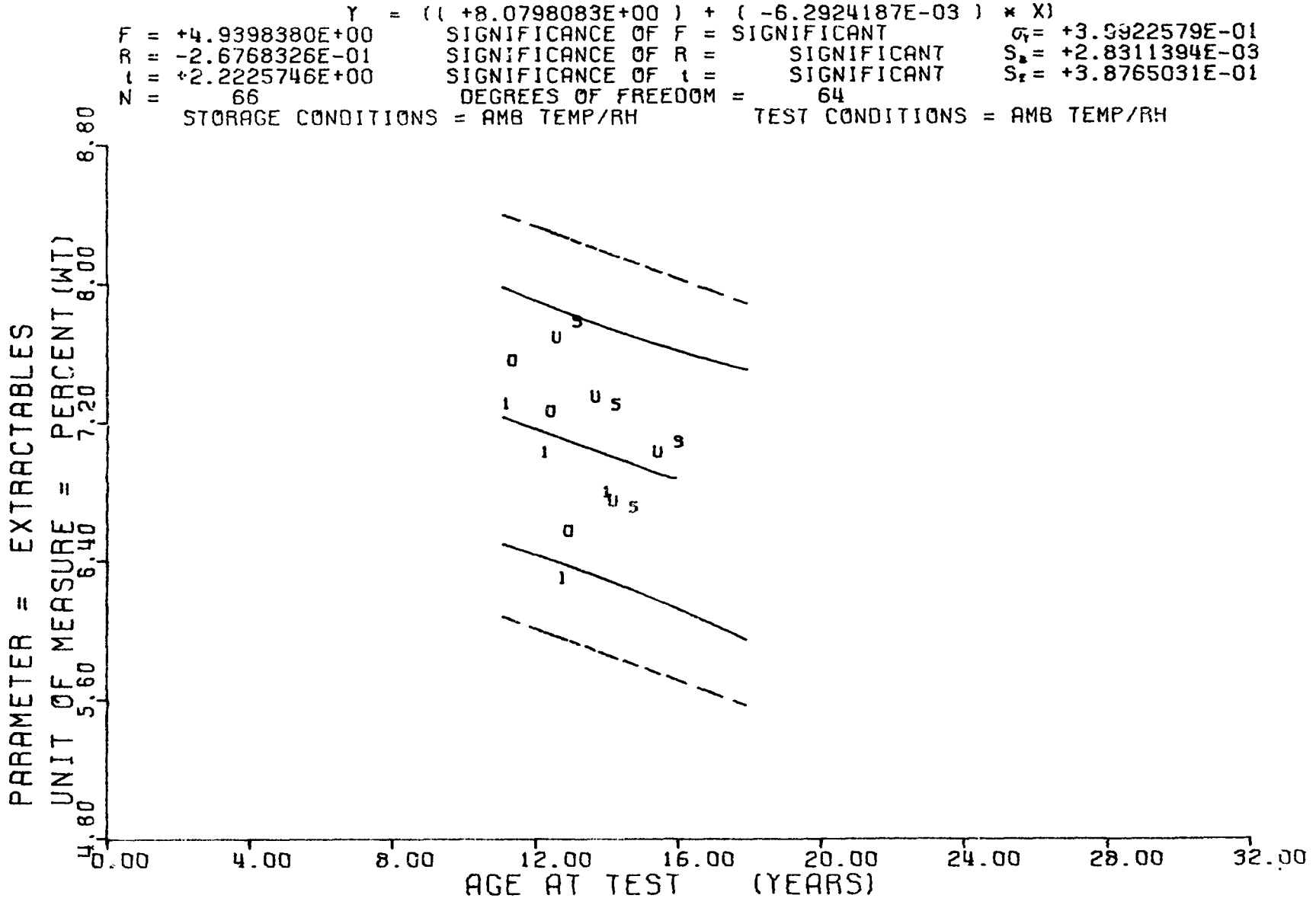

Y = ((+8.0798083E+00) + (-6.2924187E-03) * X)
F = +4.9398380E+00 SIGNIFICANCE OF F = SIGNIFICANT σY = +3.9922579E-01
R = -2.6768326E-01 SIGNIFICANCE OF R = SIGNIFICANT SB = +2.8311394E-03
t = +2.2225746E+00 SIGNIFICANCE OF t = SIGNIFICANT SE = +3.8765031E-01
N = 66 DEGREES OF FREEDOM = 64
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = EXTRACTABLES
UNIT OF MEASURE = PERCENT (WT)
8.80
8.00
7.20
6.40
5.60
4.80
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
DISSECTED MTR, STAGE 1, TP-H1011, SOL GEL, PERCENT EXTRACTABLES

Figure 47

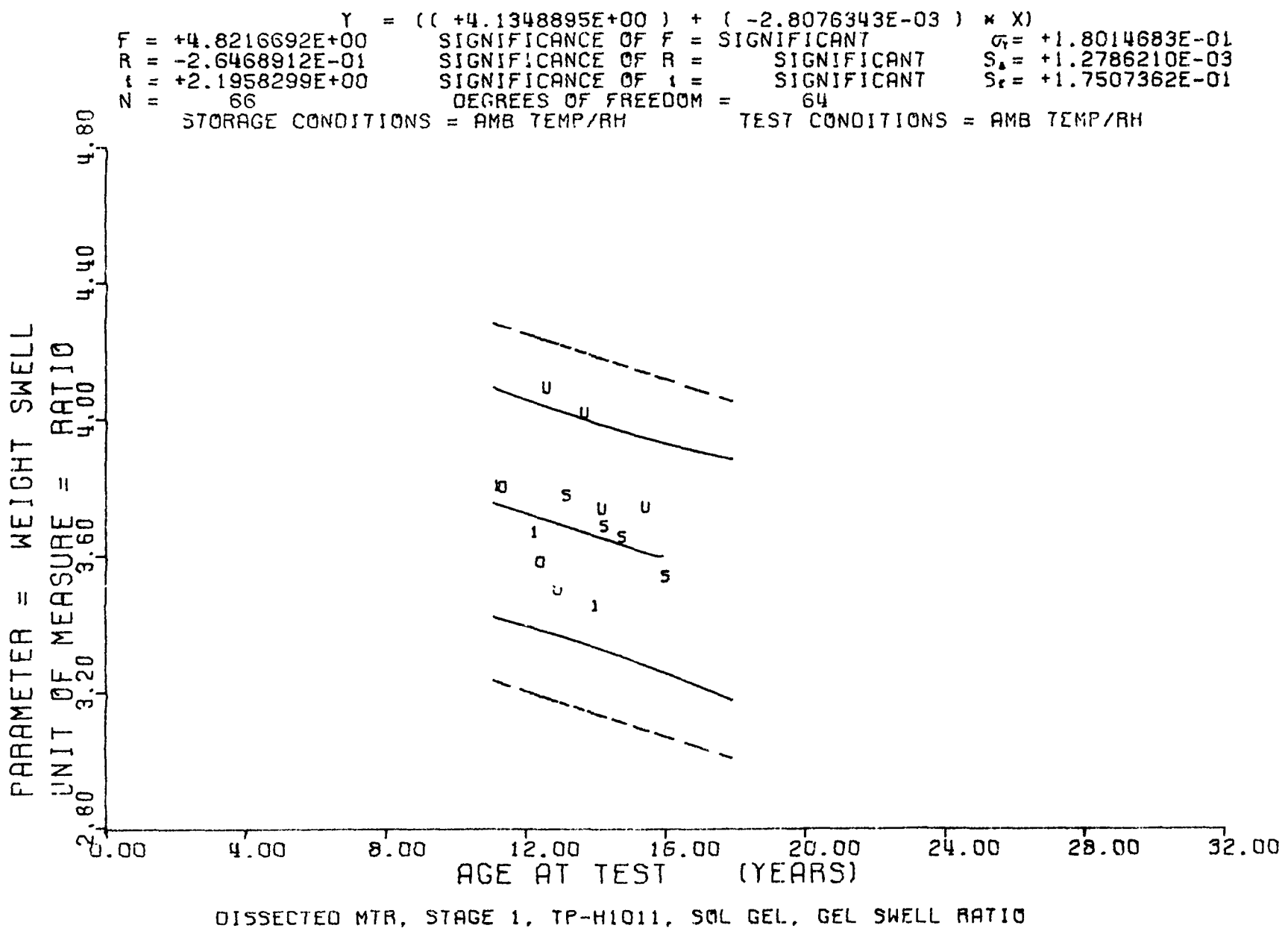

Y = ((+4.1348895E+00) + (-2.8076343E-03) * X)
F = +4.8216692E+00 SIGNIFICANCE OF F = SIGNIFICANT σt = +1.8014683E-01
R = -2.6468912E-01 SIGNIFICANCE OF R = SIGNIFICANT SA = +1.2786210E-03
t = +2.1958299E+00 SIGNIFICANCE OF t = SIGNIFICANT Sr = +1.7507362E-01
N = 66 DEGREES OF FREEDOM = 64
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = WEIGHT SWELL
UNIT OF MEASURE = RATIO
4.80
4.40
4.00
3.60
3.20
2.80
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
DISSECTED MTR, STAGE 1, TP-H1011, SOL GEL, GEL SWELL RATIO

Figure 48

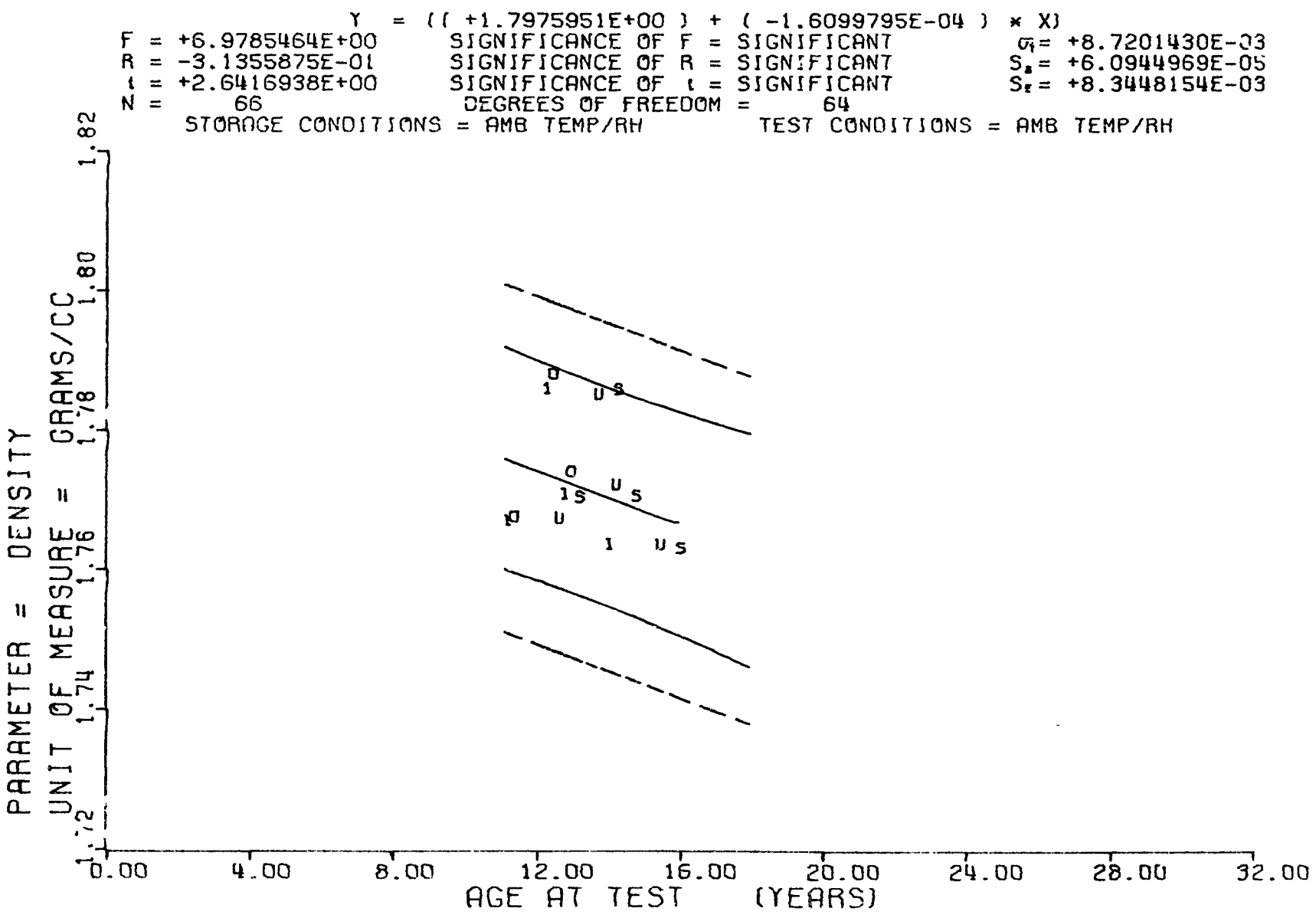
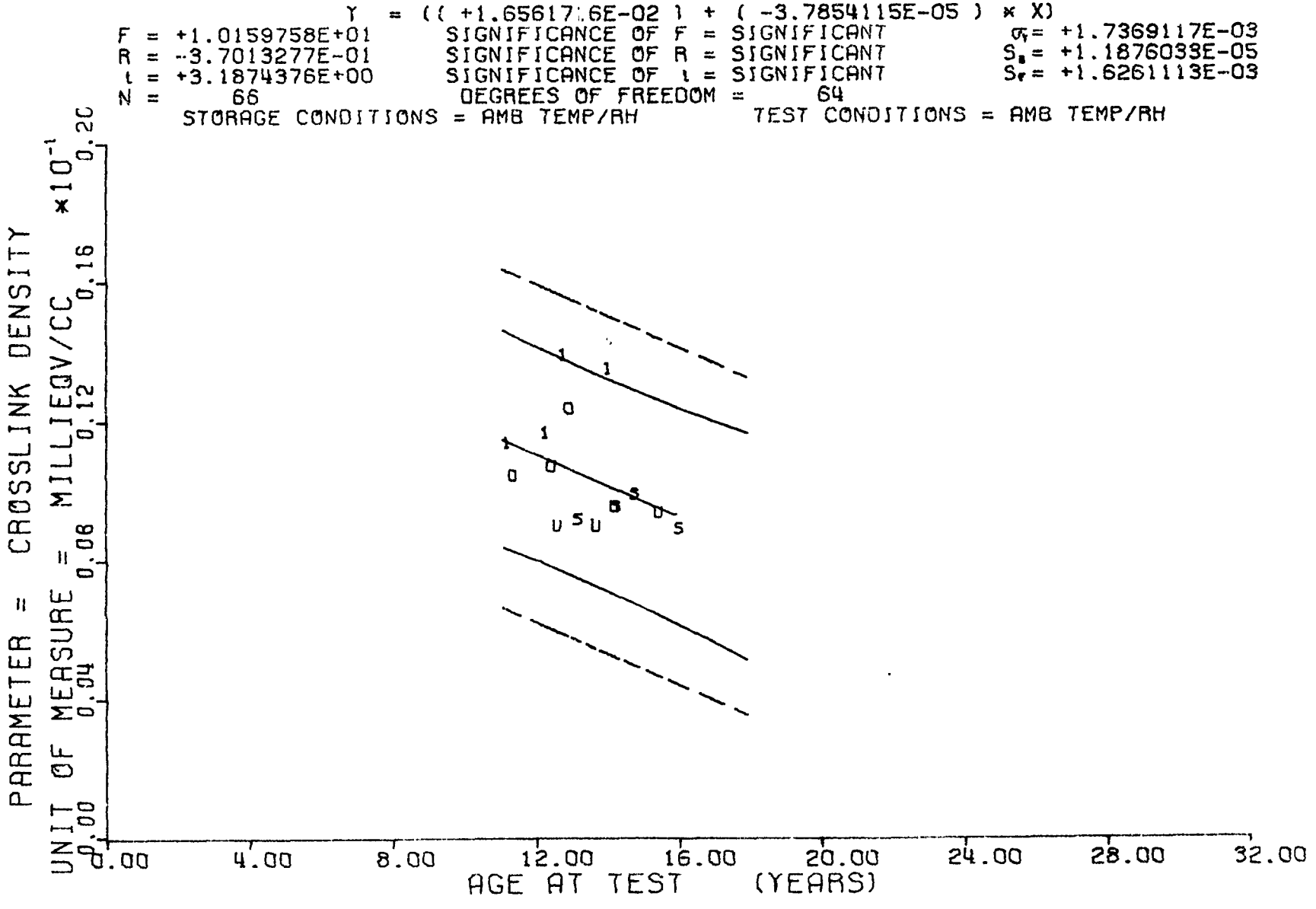
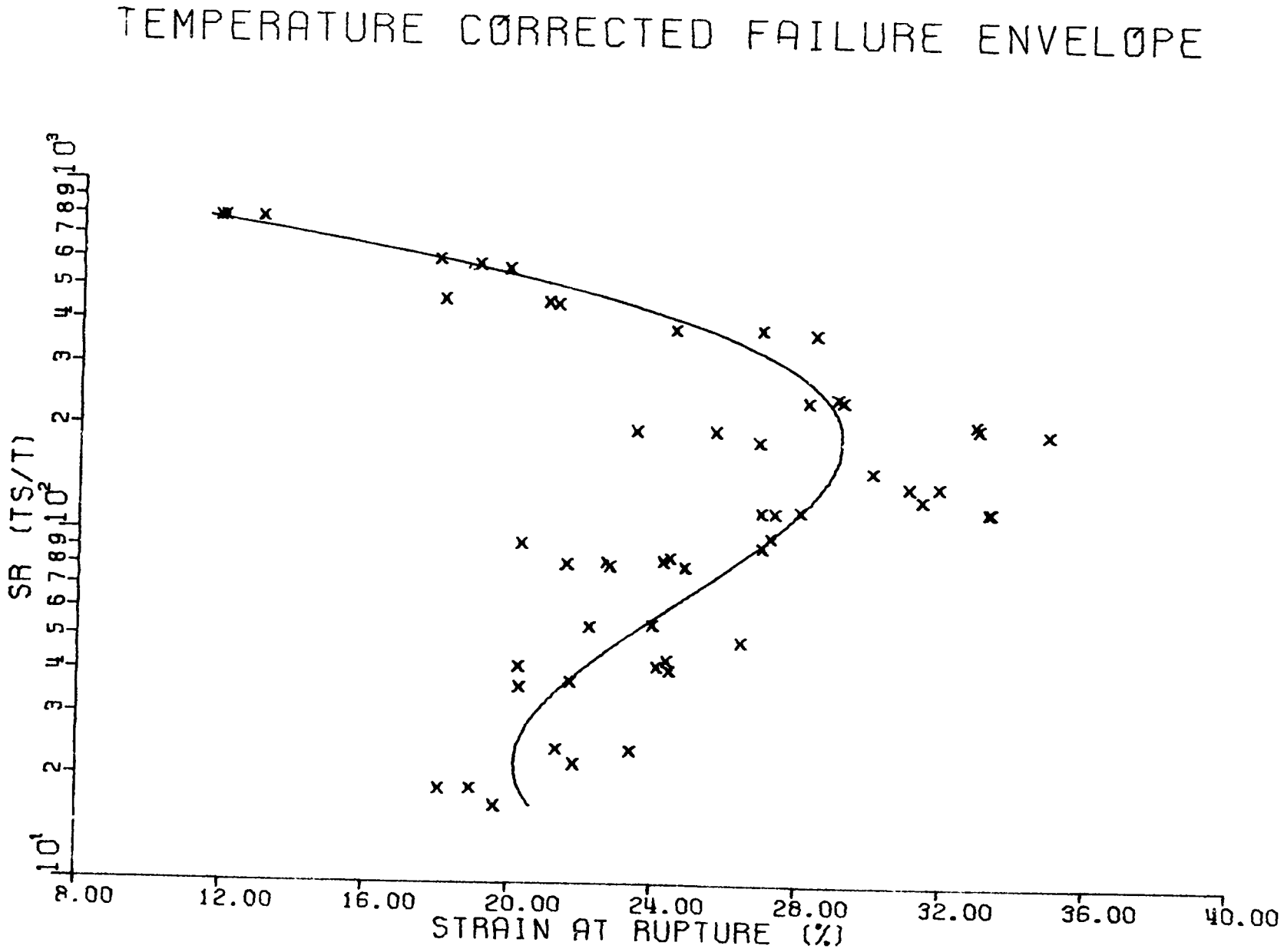

Y = ((+1.7975951E+00) + (-1.6099795E-04) * X)
F = +6.9785464E+00 SIGNIFICANCE OF F = SIGNIFICANT σ1 = +8.7201430E-03
R = -3.1355875E-01 SIGNIFICANCE OF R = SIGNIFICANT Sa = +6.0944969E-05
t = +2.6416938E+00 SIGNIFICANCE OF t = SIGNIFICANT Se = +8.3448154E-03
N = 66 DEGREES OF FREEDOM = 64
STORAGE CONDITIONS = AMB TEMP/RH TEST CONDITIONS = AMB TEMP/RH
PARAMETER = DENSITY
UNIT OF MEASURE = GRAMS/CC
1.82
1.80
1.78
1.76
1.74
1.72
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00
AGE AT TEST (YEARS)
DISSECTED MTR, STAGE 1, TP-H1011, SOL GEL, DENSITY

Figure 49



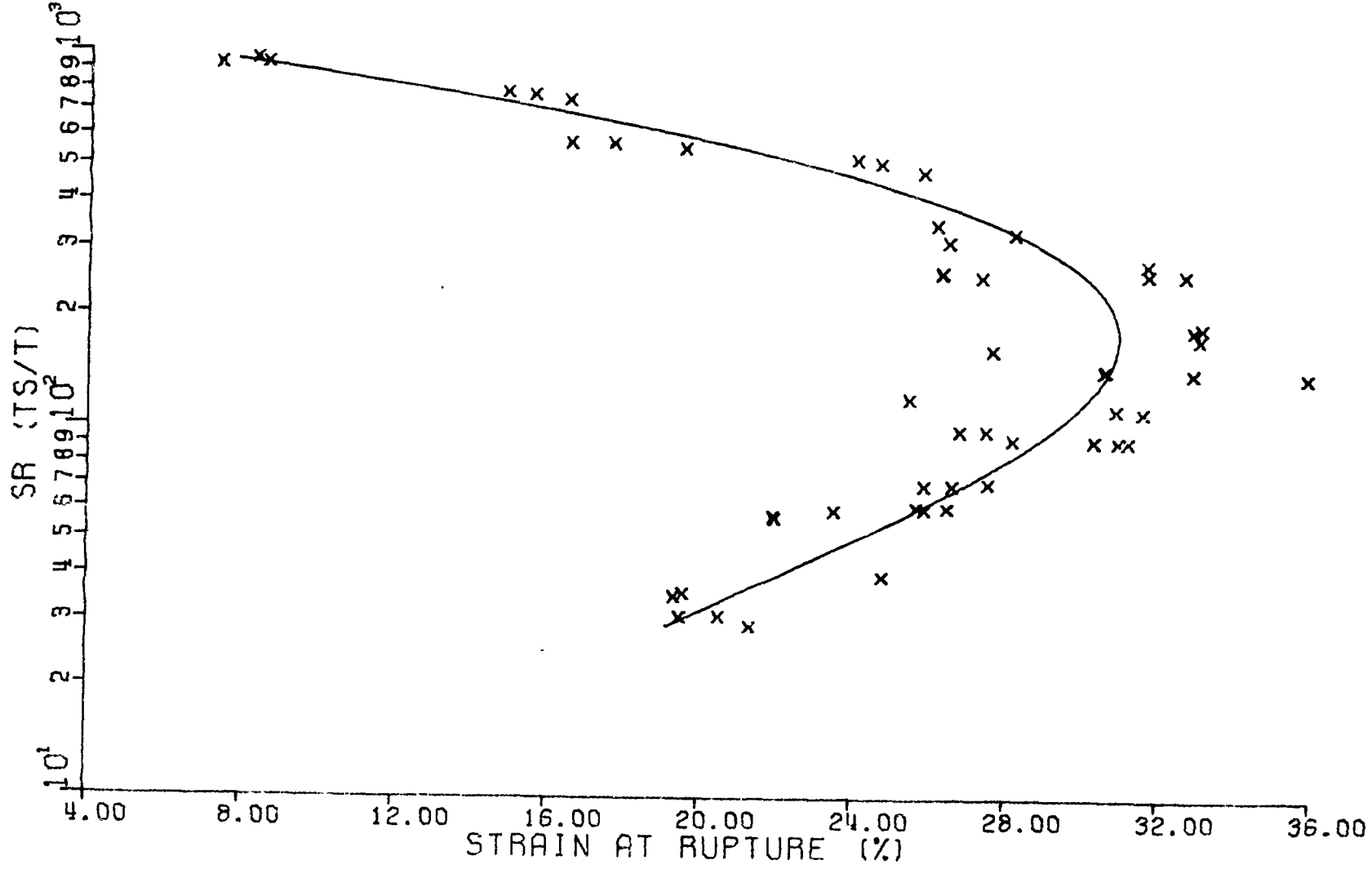
DISSECTED MTR, STAGE 1, TP-H1011, SOL GEL, CROSSLINK DENSITY

Figure 50



FAILURE ENVELOPE (MOTOR/SN STM-012) DISSECTED MOTOR, STAGE I, TP-H1011

Figure 51



FAILURE ENVELOPE (MOTOR/SN 0012199) DISSECTED MOTOR, STAGE I, TP-H1011

Figure 52

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4. TITLE *(and Subtitle)* Minuteman Stage I Dissected Motor Program		5. TYPE OF REPORT & PERIOD COVERED Test Results - Semi Annual 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) John A. Thompson		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Propellant Lab Section Directorate of Maintenance OO-ALC Hill AFB, UT 84406		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS MMRM Project M82934C- WNL 17514
11. CONTROLLING OFFICE NAME AND ADDRESS Service Engineering Division Directorate of Materiel Management OO-ALC Hill AFB, UT 84406		12. REPORT DATE March 1978 13. NUMBER OF PAGES 97
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18. SUPPLEMENTARY NOTES

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Minuteman
Solid Propellant

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

Testing was performed to determine the useful shelf/service life for LGM-30 Stage I Rocket Motors. A three year storage program for propellant and components was started in May 1961. This program was then extended to a ten year study and later continued indefinitely to assure that a deterioration in motor physical characteristics could be detected in time to take some corrective actions before the weapon system performance deteriorated below an acceptable level.

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This report covers only propellant data and limited case bond data. The malfunction of an environmental chamber destroyed component samples that had originally been part of this testing program (and the inadvertent burning of some motors during dissection reduced the material available for testing). Planned dissection of selected motors in the future will provide samples for continued component testing. Test specimens for this reporting period were obtained from motors STM-0012, 0012099, 0012199 and UP-7775 block propellant.

Separate analyses were made on the respective motors and block propellant for the first time in this report and are shown in the regressions. The plotting symbols for each motor and block propellant are listed in the statistical analyses section.

The data from this test period was combined with data from previous testing and entered into the G085 computer for storage, analysis, and regression analysis. From the statistical analysis of all data tested to date, significant degradation of the propellant does not appear likely for at least two years past the oldest data point.

Future testing will be conducted on dissected motors.